Haemato-biochemical and Therapeutic Studies on Gastrointestinal Parasitism in Horses

अश्वों में जटरान्त्रीय परजीविता पर रक्त जैव रासायनिक एवं चिकित्सीय अध्ययन

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1. INTRODUCTION

Horses have been closely associated with man since ancient times. The evidence can be obtained from old epics (Ramayana, Mahabharata) and Vedas. There are few clear references to actual horse riding in the Rigveda. In Bikaner area horse keeping is a status symbol of rich people and being used for joy riding. Some people rear the horses for small entrepreneurship like transport-tation, for processions either of ceremonial or religious nature etc.

Horses are used as means of transportation for riders, for drawing carriages, delivery vans and pulling agricultural implements, for recreational purposes like polo and racing and for research and development purposes. They may also be slaughtered for meat. In North-eastern Nigeria, the Mounted Troop Police train them to withstand loud noises, bangs and flag waving and thus use them for crowd control, land surveillance and border patrol. Furthermore, in this region, especially the Muslim dominated towns, horses are used for ceremonial purposes such as durbar, religious and traditional festivals (Nwosu and Stephen, 2005).

The total world horse population is estimated at 58 millions, according to a report compiled by the Food and Agriculture Organization of the United Nations (FAOSTAT, 2007). Equines have a prominent position in the agricultural systems of many developing countries as they act as a mean of transport for men and material and provide livelihood to a number of rural and semi-urban population of India. India holds about 0.751 million horses and ponies (Census, 2003). The equine population is unevenly distributed all over the country. Total population of horses in Rajasthan is 24.74 thousands (Census, 2007). They do suffer from a number of diseases. Parasitic infestation is a major cause of illness. Documentation of parasitic infestations of equines in our country is lacking.

Horses are said to have the largest collection of parasites of all domestic livestock. It is not unusual for a seemingly healthy horse to harbor over one-half million gastrointestinal nematode parasites. These parasites cause damage to the animals both during the infection phase when the invading larvae are undergoing early development in various tissues of the
body and then again after these larval stages have emerged and developed fully to adult parasites living in their final or predilection sites laying eggs back into the environment (Bliss, 1999).

Overall, millions of dollars are spent every year for internal parasite control in horses, however internal parasites remain one of the most important problems affecting the health and well-being of horses. The reason for this is that parasite control measures recommended and practiced over the past 25 years seems to have provided limited protection to the horse because they remove infections after these infections have already developed and the damage to the horse is already done with little or no effect on reducing environmental contamination.

Horses worldwide are exposed to a complex mixture of intestinal parasitic helminthes. When burdens are high, these parasites can seriously compromise health and welfare. Some helminth species have an extremely high prevalence and are difficult to control. The cyathostomins are the most common nematode species affecting equids worldwide. Within this group of parasites are more than 50 different species (Matthews, 2011). Various potentially pathogenic gastrointestinal parasites of horses are Parascaris equorum, Strongylus edentatus, S. equinus, S. vulgaris, Strongyloides westeri, and a range of Cyathostoma spp. (Holland et al., 2001) and other gastro-intestinal parasites of horses are Trichostrongylus axei, Habronema muscae, H. majus, Draschia megastoma, Gastero-phillus intestinalis, G. nasalis, Anoplocephala perfoliata, Faciola hepatica, Oxyurus equi (Bucknell et al., 1995).

Parasitic diseases, with a few exceptions, hardly cause mortality in equines. As a result, they have failed to draw serious research attention for their control. Consequently, limited studies have been undertaken. Parasitic diseases are responsible for the poor health of equine due to their direct effects like irritation, annoyance, intoxication, mechanical obstruction, tissue destruction, competitive food uptake and anaemia etc. As a result their condition is lost and draught power is reduced. Gastrointestinal parasites, in heavy infection may bring alteration in the normal haematological values among affected animals (Pavord and Fisher, 1987) like neutrophilia, eosinophilia and anaemia (Thamsborg et al., 1998). The biochemical
values are also affected like lower concentrations of total protein and albumin, and with higher percentages of Beta-globulin (Smets et al., 1999).

Ivermectin is a broad-spectrum parasiticide which, in the horses, is highly effective against bots, intestinal nematodes, the migratory stages of *Strongylus vulgaris*, *Habronema*, *Draschia*, and *Onchocera spp*. In cutaneous lesions, Ivermectin was introduced for horses first as a micellar formulation for parenteral use, but some adverse reactions were reported and the product was withdrawn from the market place. Adverse reactions were not seen when the same formulation was given per os with a paste formulation or with a liquid formulation for horses (Owen et al., 1988).

Ivermectin is effective against all parasitic stages of *Gasterophilus spp.*, small *strongyles*, *Dictyocaulus spp.* and the *microfilariae* of *Onchocerca cervicalis*. Although the efficacy of ivermectin against adults of *Parascaris equorum* is 95 to 100%, its efficacy against immature stages of this parasite has been suggested by some veterinary practitioners to be much lower. Ivermectin is significantly more effective against immature *Parascaris* larvae when given orally rather than by injection. Ivermectin is highly effective against adult ova-producing nematode parasites. Within 7-14 days after treatment, faecal ova counts are usually near zero. A 90% or greater reduction in eggs per gram (EPG) is maintained for at least 63 days after treatment (Bell and Holste, 1990).

Clinical parasitism is complicated because it is interrelated to a number of variables including nutrition and immune status of the animals. Horses carrying heavy worm burden can appear normal if nutrition levels are adequate. If nutrition is inadequate, the animal may begin to develop signs of clinical parasitism (Bliss, 1999).

Subclinical parasitism can be very costly because the owner is often unaware of the damage that is taking place since the parasites are not visible and lost performance can occur unknowingly. The most important aspect of subclinical parasitism, however, is the ability of subclinical infected animals to shed worm eggs into the environment producing future infections. Subclinically infected animals, even
with low worm egg counts, may be shedding thousands of eggs back in the horse’s environment every day.

Parasitic infestations are the major veterinary problems in most of the developed and under-developed countries of the world. Some parasitic infestations even cause death when the control measures are neglected and it is very important to take care of horses in investigating their parasitic diseases and to find the best possible control measures, due to their above-mentioned inevitable role in daily life (Hassan et al., 2005).

Parasitic diseases are the major obstacle in the growth and development of animal health. Incidence of clinical and sub-clinical diseases of horses can be minimized controlling the gastrointestinal parasites (Mahfooz et al., 2008). In view of this, haemato-biochemical and therapeutic studies on gastrointestinal parasitism in horses in and around Bikaner were undertaken with following objectives:

1. To find out the prevalence of gastrointestinal parasitism in horses.
2. To study clinical manifestations, if any, in parasites-infested horses.
3. To study haemato-biochemical changes in gastrointestinal parasitism in horses.
4. To study the therapeutic efficacy of ivermectin in horses.
2. REVIEW OF LITERATURE

The parasitic diseases are responsible for significant losses in the form of morbidity, poor health, loss of vigour, enteritis, oedema, working capacity etc. Internal parasites are prime cause of colic and contribute to many respiratory, digestive, and performance problems. Helminthoses may lead to immunosuppression also. The young animals and animals on poor diet tend to be more susceptible to parasitic infections. Animals suffering from current diseases are more likely to show the signs of parasitic disease. After parasitic infections some animals show severe signs or die whereas the rest of the herd demonstrates chronic, subacute or subclinical manifestation of infection.

Pertinent review of literature regarding various parameters has been reviewed under the following heading.

2.1. Prevalence

Poynter (1970) examined 16103 faecal samples from 3227 horses and found Parascaris equorum (27.4%) and Strongyloides westeri (4.4%) infections.

Dunsmore and jue (1985) conducted necropsy of 151 horses in 1979-1982. They reported that the Cyathostome and Strongylus vulgaris was 49.3 percent and 22.5 percent respectively. The Draschia megastoma was found in 66.2 percent cases.

Islam (1986) after examination of 275 horses reported 146 (53.09 percent) to be positive for helminths infestation with prevalence of Strongylus vulgaris (15.63%), Oxyuris equi (13.45%), Strongylus equines (9.09%), Parascaris equorum (8.72%), Gastrodiscus aegypticus (4.72%), Anaplocephala perfoliata (1.81%) and Dictyocaulus arnfieldi 1.45 per cent.

Jurasek (1986) examined 292 faecal samples from horses in Maputa, Czechoslovakia and reported the presence of Strongylus equinus to the extent of 97 per cent and that of Parascaris equorum upto 1.7 percent.
Silobad (1987) conducted faecal examination of 118 horses at the Zobnatica stud farm in Yugoslavia for gastrointestinal nematodes and found 83.3% foals (up to 1 year), 100% horses (1-2 years), 83.3% mares and 62.9% stallions infected. The infection of *Parascaris equorum* in these animals was 7.4, 75.0, 13.8 and 11.1% and that of *Strongyles* was 74.1, 100, 80.5 and 62.9%, respectively.

Fei et al. (1990) recovered *Parascaris equorum, Strongylus equinus, Oxyuris equi*, and third stage larvae of *Gasterophilus intestinalis* on post mortem examination of eight horses in Taipei, Taiwan.

Virga et al. (1991) examined faecal samples of 153 horses and 11 mules slaughtered at Palermo abattoir in July-November, 1990 and showed infections of strongyles (93.3%), *Parascaris equorum* (26.8%), Anoplocephalidae (3.6%) and *Strongyloides westeri* (2.4%), respectively.

Santos et al. (1992) studied the occurrence of helminths in the faeces of horses (*Equus caballus*) in Bahia State, Brazil. A total of 102 faecal samples were examined. Among these 70 samples (68.6%) were infected with nematodes, such as *Strongylus spp.* (32-67%), *Strongyloides westeri* (13-27%), *Trichostrongylus axei* (0-12%) and *Parascaris equorum* (9-36%), respectively.

Epe et al. (1993) examined 9192 faecal samples of horses during 1984 to 1991 and detected strongylids (55.5%), *Parascaris equorum* (4%), anoplocephalids (2.2%), *Strongyloides westeri* (1.6%), *Oxyuris equi* (0.7%), *Eimeria leuckarti* (0.6%), *Fasciola hepatica* (0.2%) and *Dictyocaulus arnfieldi* (0.04%), respectively.

Battelli et al. (1995) conducted faecal examination of 51 horses (<3 years old) from studs in the province of Udine, Italy in 1993 and revealed coccidian oocysts of *Eimeria leuckarti* in 6 foals, 2 stallions and 1 mare.

Demir et al. (1995) while examining the faecal samples of 430 horses from Bursa, Turkey found 391 (90.9%) horses infected with the parasites namely *Dicrocoelium dendriticum* (1.1%), *Fasciola spp.* (1.6%), *Anoplocephala spp.* (1.3%), *Strongyloides westeri* (0.4%), *Strongylidae* (90.9%), *Parascaris equorum* (5.1%),
Oxyuris equi (1.3%), Trichuris spp. (1.1%) and Probstmayria vivipara (0.4%), respectively.

Krecek et al. (1995) carried out a study on the parasites of 3 wild horses from the Namib Desert, Namibia and found all infected with Habronema muscae, Oxyuris equi, Strongylus spp. and Gasterophilus species.

Subbarayudu et al. (1995) conducted a survey based on faecal sample examination in Hyderabad, India and reported that out of 550 horses, 290 (52.7%) were infected with Strongyles.

Sengupta and Yadav (1997) carried out a study on pony mares in Udham Singh Nagar, U.P., India and reported the infection of Strongylus spp. (64.52%), Trichonema spp. (17.74%) and Gastrodiscus aegyptiacus (30.90%), respectively.

Langrova (1998) studied prevalence of helminths by faecal examination in thoroughbred horses on a stud farm near Prague, Czech Republic and recorded Strongylidae (60.5%), Strongylinae (8.15%), Parascaris equorum (2.91%), Strongyloides westeri (1.88%) and Habronema spp. (0.73%), respectively.

Sengupta and Yadav (1998) found that the parasitic infection rate was higher in unorganized husbandry practices (128 equines: 13 horses, 17 donkeys, 98 mules) than in organized practices (141 equines: 84 horses, 54 donkeys, 3 mules) in Haryana. The Strongylus spp. was the major parasitic infection with prevalences of 57.81% in the unorganized sector and 14.18% in the organized sector. The other species recorded were Trichonema spp. (15.63%), Paramphistomum spp. (7.81%), Trichostrongylus spp. (6.25%), and Oxyuris equi (0.78%) in the unorganized sector, and Anoaplocephala spp. (2.12%), Parascaris equorum (3.54%), Oxyuris equi (2.83%) and Eimeria leuckarti (1.41%) in the organized sector.

Piskin et al. (1999) examined faeces of 72 horses and found 30 horses infected with one or more helminth species. The species identified were Strongyle type in 22, Strongyloides westeri in 5 and Parascaris equorum in 1 horse. Oxyuris equi was detected in 2 out of 63 horses examined by the cellophane tape method.
Mundim et al. (2000) investigated 175 faecal samples of horses collected from Brazil and revealed that 163 samples (93.14%) were infected with helminth ova. The species identified were strongylids (92.57%), Parascaris equorum (9.71%), Oxyuris equi (4.0%) and Strongyloides westeri (5.14%), respectively.

Omar et al. (2000) examined 18 faecal samples from 18 miniature horses imported into Egypt from North Carolina, USA. Three species of helminths and three species of Eimeria were detected with an overall prevalence of 24% and 46.3%, respectively. The helminths recorded were Parascaris equorum (44.5%), small strongyles (16.7%) and Dictyocaulus spp. (11.1%), respectively.

Beelitz and Gothe (2001) tested four coprological methods for the detection of Anoplocephala perfoliata eggs in faeces and found that sedimentation/flotation methods was best for the detection of ova in 18 (47.4%) out of 38 parasitized horses.

Holland et al. (2001) recorded Strongyle infections in 247 horses in 2 geographical areas, the Red River delta and the mountainous area of North Vietnam. The prevalence of Strongylus spp. was <7 per cent.

Konigova et al. (2001) conducted coprological examination of 913 horses from 46 stud farms and recorded the prevalence of equine gastrointestinal parasites in the Slovak Republic. The prevalence of Strongyle type and Parascaris equorum eggs was 63.75 and 10.95%, respectively. Strongyloides westeri, Dicrocoelium dendriticum and Anoplocephala spp. were also detected in low numbers.

Lonc et al. (2001) examined faecal sample of domestic animals at farms of Silesia, Poland and found highest prevalence of parasites (52%) in horses. Ninetyeight English blood-horses were mainly infected with Parascaris equorum and Strongylids.

Banerjee et al. (2002) examined faecal samples of mules in Tarai region of Uttaranchal State and recorded strongyles, Oxyuris equi, Parascaris equorum and Amphistomes.

Gawor (2002) recorded prevalence of intestinal parasites in riding horses and revealed strongyles (81%), ascarids (5.6%) and tapeworms (2.1%), respectively.
Konigova et al. (2002) investigated faecal samples of 913 horses from 46 stud farms in Slovakia and revealed family Strongylidae (63.8%) and Parascaris equorum 10.9 per cent. Other parasite eggs were also detected in low numbers.

Montinaro et al. (2002) studied epidemiology of gastrointestinal nematode infections in horses in Sardinia. A total of 356 faecal samples were collected and examined for nematode eggs and prevalence of 63.5% and 12.9% was recorded for gastrointestinal strongyles and ascarids, respectively.

Rehbein et al. (2002) examined 2034 and 646 faecal samples of horses from Germany and Austria, respectively and the prevalence of Strongylus spp. (76.6 and 61.3%), Parascaris equorum (4.0 and 4.3%), Oxyuris equi (0.6 and 0.3%), Strongyloides westeri (0.1 and 0.3%), Anoplocephala spp. (9.8 and 10.8%), and Eimeria leuckarti (0.1 and 0.9%) infections were recorded. Habronema spp. and Paranoplocephala spp. were observed in 0.05 and 0.5% of samples from Germany.

Singh et al. (2002) while conducting epidemiological study on gastrointestinal parasites in equines in Uttaranchal and Uttar Pradesh examined a total number of 600 faecal samples and found strongyles (86.65%), Parascaris equorum (25.33%) and amphistomes (12.94%) infections and few animals were also infected with Oxyuris equi, anoplocephalids and coccidia organisms.

Gul et al. (2003) examined faeces of 464 horses and 110 donkeys and showed that 327 of 464 (70.5%) horses and 85 of 110 (77.3%) donkeys were infected with helminth parasites. The species recorded in horses were Strongylidae (62.7%), Strongyloides westeri (5.8%), Parascaris equorum (3.2%), Anoplocephala spp. (2.4%), Fasciola hepatica (0.9%), Oxyuris equi (0.6%), and Paranoplocephala mamillana (0.2%) and in donkeys Strongylidae spp. (72.7%), Strongyloides westeri (13.6%), Parascaris equorum (2.7%), Fasciola hepatica (0.9%), Oxyuris equi (0.9%) and Dicrocoelium dendriticum (0.9%), respectively.

Sengupta and Yadav (2003) recorded prevalence of gastrointestinal helminths in equines and found Strongylus spp. predominantly infecting 61.62% horses, 50.00% donkeys and 47.14% mules. Other parasites like Dictyocaulus arnfieldi,
Oxyuris equi, Strongyloides westeri, Anoplocephala spp. and Paramphistomes spp. were also recorded in some hilly pockets of western Himalayas.

Aydenizoz (2004) processed 100 faecal samples of horses in Kirikkale, Turkey and found that 74% of the horses were infected with different helminth species. The helminth species found were Strongylidae (71%), Parascaris equorum (3%), Anoplocephala perfoliata (1%), and Dicrocoelium dendriticum (1%). Of these horses 72% were infected with only one helminth species, and only 2% of the horses were infected with two species.

Bakirci et al. (2004) conducted a survey to characterize the respiratory and gastrointestinal parasites in 85 horses of varying age, gender and breeds in Turkey. The faecal samples were examined by flotation, sedimentation and the Baermann-Wetzel method. The result showed that 64 horses (75.29%) were infected with atleast one (62.35%) or two (12.94%) parasites, respectively. The species encountered in the study were Strongylidae (71.76%), Parascaris equorum (8.23%), Dictyocaulus arnfieldi (1.17%), Oxyuris equi (1.17%), Anoplocephalidae (1.17%) and Eimeria leuckarti (5.88%), respectively.

Cirak et al. (2004) studied daily faecal egg output of 6 thoroughbred Arabian horses for 3 days after anthelmintic treatment in Turkey, and observed Anoplocephala magna in 2 of 6 horses.

Epe et al. (2004) examined 4399 faecal samples in Germany during 1998 - 2002 from horses and revealed strongylids (37.4%), anoplocephalids (1.4%), Strongyloides westeri (1.3%), Parascaris equorum (0.9%), Oxyuris equi (0.04%), Eimeria spp. (0.04%) and Fasciola hepatica (0.04%), respectively.

Gundach et al. (2004) analysed faeces of 899 horses of different breeds 1-16 years of age by floatation method in Lublin district and recorded Eimeria leuckarti, Anoplocephalid, Ascarid and Strongylid infections.

Kornas et al. (2004) recorded the intestinal parasite infection of horses from riding clubs in Krakow, Poland and revealed that most common parasites were strongyles (Strongylidae). The seasonal mean prevalence of infection (April-October)
in 2002 were higher in horses under pasture system (73.9%) than in horses on paddocks with grass (42.1%) and horses on paddocks without grass 19.2 per cent.

Lyons and Tolliver (2004) examined oocysts in the faeces of 733 thoroughbred foals on 14 farms in central Kentucky, and recorded Strongyloides westeri (1.5%), Parascaris equorum (22.4%), strongyles (27.6%) and Eimeria leuckarti (41.6%) in faeces of foals. The foals were infected with S. westeri on six farms (42.9%), with P. equorum on 12 farms (86%) and with strongyles and E. leuckarti on all 14 farms (100%), respectively.

Alcaino et al. (2005) analysed 666 faecal samples of thoroughbred racehorses in central zone of Chile and found that 6% of race horses were positive for the presence of Fasciola hepatica eggs in the faecal sedimentation test.

Eslami et al. (2005) recorded Parascaris equorum, Oxyuris equi, and strongyle eggs in 13.8%, 17%, and 28.3% of tested faecal samples, respectively in 290 racehorses on 20 private horse farms in Iran.

Fikru et al. (2005) conducted coprological study (n=388) in western highlands of Oromia, Ethiopia and recorded overall prevalence of small and large strongyles (92.8%), Parascaris equorum (17.1%), Dictyocaulus arnifieldi (2.6%) and Oxyuris equi (2.1%), respectively.

Fioretti et al. (2005) collected 300 faecal samples of horses in Umbria and found that total prevalence of Cyathostominae and Anoplocephalidae were 65.93% and 25.6 per cent, respectively.

Maddox et al. (2005) found 4% prevalence of Anoplocephala perfoliata in 5 regions of Denmark in 100 clinically healthy horses after their coprological examinations.

Gawor et al. (2006) studied parasitic infections in riding horses from one stud farm and 5 riding clubs. The species recorded in stud farm horses were strongyles (71.0%), Parascaris equorum (0.5%) and Anoplocephala spp. (6.7%). Strongyles (36.30-87.10%), Parascaris equorum (3.7-21%) and Anoplocephala spp. (0-1.8%) were recorded in club horses.
Katooch et al. (2006) analyzed 60 faecal samples in Spiti horses of Himachal Pradesh and observed that the overall incidence of strongyles, lungworms, *Parascaris equorum*, *Habronema* spp. and *Strongyloides westeri* were 75, 18.37, 10.2, 3.33 and 1.67 per cent, respectively.

Roelfstra (2006) while studying the seasonal dynamics of gastrointestinal nematode egg production in horses observed high prevalence of *Anoplocephala* spp. infection on one breeding farm.

Slivinska (2006) studied prevalence of gastrointestinal parasites community of the Przewalski’s and domestic horse and revealed Strongylid (100%), *Oxyuris equi* (81%), *Parascaris equorum* (19%) and Tapeworms (14.3%) infections; *Gasterophilus* spp. were also recorded in the Chernobyl exclusion zone.

Altas et al. (2007) examined faecal samples of 92 Arabian horses in Sanliurfa region of Turkey and found overall 76.08% prevalence of helminth infections. Besides *Strongylus* spp. (63.04%), which was predominant, other species recorded were *Dictyocaulus arnfieldi* (2.17%), *Oxyuris equi* (7.60%) and *Parascaris equorum* (22.82%), respectively.

Dorchies et al. (2007) carried out faecal examination in 1049 samples from the Equine Hospital of Toulouse Veterinary School or from equine practitioners and found that 55.7% of the samples were positive for digestive strongyles and the prevalence of *Anoplocephala* spp. was 2.2 per cent.

Paudel (2007) found that the prevalence of gastrointestinal parasites was 80.48% (33/41) with *Strongylus* spp. (48.78%), *Trichostrongylus axei* (31.70%), *Parascaris equorum* (21.95%), *Trochonema* spp. (17.07%), *Gastrodiscus* spp. (7.31%), and *Habronema* spp. (4.87%) infections in horses of Sainik stud farm, Chitwan.

Uslu and Guclu (2007) examined faecal samples from 111 horses and found the infections of Strongylidae (100%), *Parascaris equorum* (10.81%), *Strongyloides westeri* (7.2%), *Fasciola* spp. (3.6%), Anoplocephalidae (2.7%), *Oxyuris equi* (1.8%),
Trichuris spp. (0.9%), Dicrocoelium dendriticum (0.9%), Eimeria leuckarti (4.5%) and Eimeria spp. (12.61%), respectively.

Benavides et al. (2008) reported (31.7%) prevalence of Anoplocephala perfoliata in 135 equids (105 horses, 2 mules and 28 asses) in the Northwest regions of Colombia by using methods of sedimentation / flotation.

Getachew et al. (2008) conducted coprological examination in 402 horses and donkeys in the regions of Ada, Akaki, Bereh and Boset in Ethiopia and recorded 16.2% prevalence of Parascaris equorum.

Kaur and Kaur (2008) studied the prevalence of gastrointestinal parasites in horses of Patiala and its adjoining areas and found that 76.47% of the horses were infected with parasites including Parascaris equorum (84.61%), Strongyloides westeri (76.92%) and Trichostrongylus spp. (38.46%), respectively.

Mahfooz et al. (2008) detected the prevalence and anthelmintic efficacy of Abamectin against gastrointestinal parasites under field conditions in 100 horses from Faisalabad, Punjab, Pakistan. The overall prevalence of gastrointestinal parasites was 75%, including Strongylus spp. (50%), Oxyuris equi (12%), Parascaris equorum (8%) and mixed infections 5 per cent, respectively.

Pandit et al. (2008) collected 935 faecal samples and examined by sedimentation and flotation techniques to determine the prevalence of gastrointestinal parasites in horses kept under unorganized husbandry in Kashmir valley of Jammu and Kashmir state, India. A total of 872 samples (93.26%) were found positive for various types of gastrointestinal parasites. The common parasites observed were Strongylus spp. (81.19%), Dictyocaulus spp. (14.10%), Oxyuris equi (9.40%), Paranoplocephala spp. (8.14%), Strongyloides westeri (6.19%), Parascaris equorum (4.01%), Amphistome spp. (0.91%) and Eimeria spp. (0.34%), respectively.

Veronesi et al. (2008) while performing faecal examinations on eighty three horses from 13 breeding farms in Tuscany and Lazio (Central Italy) found 86.74% and 14.45% prevalences for intestinal strongyles and cestode infections, respectively.
Papazahariadou et al. (2009) examined 223 faecal samples of stabled (150) and grazing (73) horses from various parts of central and northern Greece and found that 77 (34.5%) horses in the study were infected with one or more parasite species. In the stabled horses, the most common parasitic eggs were Strongyles, Strongyloides westeri, Anoplocephala spp. and Habronema spp., Parascaris equorum, oocysts of Eimeria spp. and Cryptosporidium spp. were common in the grazing horses.

Khan et al. (2010) examined 150 faecal samples of each of paddock horses, donkeys and mules of Mona Remount Depot, Sargodha, Pakistan to record the prevalence of Parascaris equorum and found this infection in 54 (36%) horses, 47(31%) donkeys, and 42 (28%) mules.

Pilania et al. (2010) reported overall prevalence of gastrointestinal parasitism in horses from five fairs of Rajasthan to be 33.24 per cent. The maximum prevalence of gastrointestinal parasites was 46.66% at Tilwara fair.

Tavassoli et al. (2010) examined faecal samples for detection of gastrointestinal parasites, collected from 221 working horses from September 2002 to May 2003 from 14 villages in Urmia, North West of Iran. Faecal samples of 46 horses (20.8%) were negative for parasite eggs or oocysts. One hundred and seventy five positive horses (48.9%) were infected with a single parasite type and 49 (22.2%) and 18 (8.1%) of horses had multiple infections with two and three parasites, respectively. The highest prevalence and intensity rate belonged to small Strongyles. The overall prevalence of intestinal parasites was 72.9% whereas Oxyuris equi and Parascaris equorum were 22.6 and 12.2 per cent respectively.

Anazi and Alyousif (2011) conducted necropsy for 45 horses from September 2006 to November 2007 in the Riyadh region, Saudi Arabia. They found 39 out of 45 horses were infected with intestinal parasites with an infestation rate of 86.6 per cent. Infestations with seven nematode species and two species of Gasterophilus larva were found. The most prevalent parasites were Strogyloides westeri (64.4%) and Parascaris equorum (28.8%) followed by Habronema muscae 22.2 per cent. Trichostrongylus axei and Oxyuris equi were less common at (11.1%) and (8.8%), respectively.
Hinney et al. (2011) examined the prevalence of helminths in the horse population of the state of Brandenburg, Germany. One hundred and twenty-six horse farms in the state were selected by randomized stratified sampling. In total, 1,407 horses across all farms were examined coproscopically and found the prevalence of *Cyathostominae* (98.4%), ascarids (16.7%), tapeworms (14.3%), pinworms (8.7%) and *strongyloides* 4.0 per cent. The large strongyle *Strongylus vulgaris* were identified on only one farm. Liver flukes and lungworms were not found.

Kuzmina et al. (2011) examined strongylid communities in horses, performed on 51 domestic horses from Southern Poland and Western Ukraine. In Poland, 25 strongylid species were found and large strongyles were found in 23.1 % of horses and composed 0.56 % of total strongylid number. In Ukraine, 19 species were found and *Strongylinae* were found in 17.4 % of horses and composed 0.07 % of community.

### 2.2. CLINICAL SIGNS

Duncan and Pirie (1975) reported the clinical signs associated with single experimental infection of *Strongylus vulgaris* in worm free pony foals. The major clinical signs, which become apparent in the infected foals during the first three weeks were pyrexia, anorexia, dullness and abdominal pain.

Srihakim and Swerczek (1978) conducted a trial on Parasite-free pony foals (*n* = 10) which were infected orally with 1000,000 *Parascaris equorum* embryonated eggs. One pony foal each was euthanized on days 1, 3, 5, 7, 11, 16, 23, 27, 42, or 80 after infection. Foals infected for more than 7 days showed signs of coughing, anorexia, rough coat, and weight loss.

Jasko and Roth (1984) observed that those horses affected with strongylosis showed chronic weight loss. The diagnosis of granulomatous colitis due to mucosal stage of Cyathostomes (small strongyles) should be considered in those cases exhibiting weight loss and intermittent diarrhoea.
Giles *et al.* (1985) recorded clinical findings in 15 cases (aged 1 to 16 years) and reported that there was sudden onset of chronic diarrhoea with weight loss, progressing in many cases to emaciation and death.

Reinemeyer (1986) noted that in equine Cyathostome infection may result in anorexia, weight loss, diarrhoea, colic, and death.

Khallaayoune (1991) reported *Strongylus vulgaris* is the most pathogenic in equine, causing unthriftiness, weakness and increased susceptibility to other infection and even death and fatal colic could also have arisen from strongylid overload.

Cohen *et al.* (1992) diagnosed a case of eosinophilic gastro enteritis in a horse gelding caused by *Strongylus edentatus* in Texas, U.S.A. The animal had the history of weight loss, depression and dermatitis of coronary bands.

Kelly and Fogarty (1993) reported loss of three horses due to larval cyathostomiasis in a thoroughbred stud farm in Irish Republic. The Animals were less than four years of age and showed the symptoms of acute weight loss, chronic diarrhoea and oedema prior to death.

Reilly *et al.* (1993) observed two horses with sub acute fatal diarrhoea suggested an association between the diarrhoea and damage to the colonic and caecal musosa caused by large numbers of cyathostome larvae (larval cyathostomiasis). The affected animals deteriorated rapidly, and died after a short illness.

Reid *et al.* (1995) observed 87 cases of cyathostomiasis in horses and found chronic diarrhoea occur due to cyathostomiasis.

Murphy *et al.* (1997) reported most common clinical manifestation of cyathostome infection in horses associated with diarrhoea, rapid weight loss and subcutaneous oedema.
Murphy and Love (1997) observed 9 cases of experimental cyathostome infection in ponies and reported that all infected ponies showed a marked reduction in weight gain, diarrhoea and colic.

Proudman et al. (1998) studied a association between the equine intestinal tapeworm *Anoplocephala perfoliata* and specific type of intestinal disease and found that 22% spasmodic colic cases were associated with tapeworm infection. They observed *Anoplocephala pertoliata* is a significant risk factor for spasmodic colic and ileal impaction colic in the horses.

Thamsborg et al. (1998) conducted a trial on 12 standard bred foals (age 3-6 months) with little previous exposure to parasites, were allocated to 2 groups and put onto pasture with low (group L) or high (group H) levels of larval contamination of large strongyles and cyathostomes. Foals in group H become clinically more affected than those of group L in that they showed loss of vigour, weight gain depression, intermittent soft faces and inappetence.

Love et al. (1999) reported principle clinical effect of cyathostomosis in horses in weight loss, affected individuals may exhibit other sings including diarrhoea and/or subcutaneous oedema and/or pyrexia.

Lyons et al. (2000) reported cyathostomiasis has become increasingly recognized as a clinical problem of horses in the United States. Typical clinical signs include diarrhoea, ventral abdominal oedema, pyrexia, colic, weight loss and poor body condition.

Mair et al. (2000) reported the clinical and pathological features of 4 horses affected by caecocaecal or caecocolic intussusceptions associated with larval cyathostomiasis. They found variable signs including diarrhoea, pyrexia, weight loss and subcutaneous oedema and cyathostome larvae were identified in the faeces of 3 of the horses.

Proudman and Holdstock (2000) observed that an increase in tapeworm infection intensity which may in turn lead to an increased incidence of colic.
Furthermore, it provides support to the hypothesis that the risk of ileal impaction colic and spasmodic colic increases with tapeworm infection intensity.

Sequeira et al. (2001) reported that gasterophilosis is characterized by difficulties in swallowing (throat localization of the immature stages), gastrointestinal ulcerations, gut obstructions or volvulus, rectal prolapses, anaemia, diarrhoea and digestive disorders.

Dowdall et al. (2002) reported clinical signs of cyathostomosis in horses is diarrhoea, colic weight loss and malaise, and in up to 50% of cases, the disease results in death.

Gasser et al. (2004) observed infections of equines with parasitic nematodes of the order Strongylida are of major veterinary importance. The L4s and L5s of *Strongylus vulgaris* migrate through the arterial system and causes 'Verminous arteritis'. Thrombus formation can block arteries causing infarction of intestinal walls and intermittent lameness, and in commonly associated with clinical signs of marked pyrexia, anorexia, severe colic and death.

Hubert et al. (2004) observed the clinical signs of parasitized ponies included depression, pyrexia, variable periods of anorexia and decreased weight gain.

Matthews et al. (2004) reported intestinal helminths are an important cause of equine disease. The cyathostominae can be extremely pathogenic and high levels of infection result in clinical symptoms ranging from chronic weight loss to colic, diarrhoea and death. The *Anoplocephala perfoliata* has assumed a clinically important role in horses. This parasite has been shown to be a significant cause of equine colic.

Hassan et al. (2005) reported that the most characteristic signs observed are anaemia, weakness, emaciation, sometimes colic and diarrhoea in case of parasitic infestation in horses.

Nwosu and Stephen (2005) observed horses suffer from a variety of parasitic infections especially helminthoses that could result in anaemia, diarrhoea, reduced reproductive, work performance and death may also occur in some cases.
Otranto et al. (2005) observed that Gasterophilosis is characterized by difficulties in swallowing, gastrointestinal ulcerations, gut obstructions or volvulus, rectal prolapses, anaemia, diarrhoea and digestive disorders.

Boyle and Houston (2006) reported that Parascaris infections may cause respiratory symptoms and bad appetite, along with weakness, decreased growth, enteritis and occasionally obstruction and peritonitis.

Donato et al. (2006) observed gastric habronemosis of horses caused by *Habronema microstoma* and *Habronema muscae* and characterized by catarrhal gastritis, diarrhoea, progressive weight loss and ulcers.

Peregrine et al. (2006) reported 24 cases of larval cyathostominosis have diagnosed in horses and found clinical signs that are typically associated with larval cyathostominosis include weight loss, weakness, acute or chronic diarrhoea, pyrexia, subcutaneous oedema and colic.

Gokcen et al. (2008) reported that clinical signs showed by horses infested by Gasterophilus may include swallowing, gastrointestinal ulcerations, gut obstructions or volvulus, rectal prolapses, anaemia, diarrhoea or digestive disorders.

Williams et al. (2008) reported infection with the tapeworm anoplocephala perfoliata has been found to be associated with equine colic in horses in the United Kingdom. Using a matched case-control study design data collected from 117 pairs of horses in Ontario were examined for evidence of associations between risk of colic and *Anoplocephas perfoliata* infection.

Corning (2009) reported small strongyles also have a remarkable ability of pathogenicity to the horse from the moment that they enter its gut. As common with other nematodes large number of adult worms may cause clinical symptoms such as lethargy, sudden weight loss, debilitation and diarrhoea.

Umur and Acici (2009) observed that *Parascaris equorum* infections are commonly associated with signs of lethargy, inappetence and coughing, nasal discharge, and decreased weight gain.
Reinemeyer and Nielsen (2009) reported equids are hosts to dozens of species of internal parasites. Only three common parasites of horses are likely to be manifested as colic: *Strongylus vulgaris*, *Parascaris equorum* and *Anoplocephala perfoliata*. The most consistent sign was intermittent colic, horse showed sweating and rolling as clear manifestations of abdominal pain. Horses were often feribrile and depressed with elevated heart rates and hypermotility of the intestine. Death was a common outcome in many cases.

Hassan *et al.* (2010) recorded clinical findings in 76 farm horses (Arabian and Thoroughbred), up to three years age, and reported that different clinical signs in the form of diarrhoea, emaciation, fever, recurrent colic and lameness in case of *Strongylus vulgaris* infection.

Saeed *et al.* (2010) studied that the clinically infected horses exhibit signs of unthriftiness, anaemia, colic and diarrhoea in case of strongylosis.

McWilliam *et al.* (2010) reported parasitic nematodes of the group cyathostominae are an important cause of disease in horses. They found clinical sings of cyathostomosis in horses is diarrhoea, weight loss, colic and oedema.

Traversa (2010) reported that small strongyles or “cyathostomins” play a relevant pathogenic role in horses, causing clinical signs like lethargy, sudden weight loss, debilitation, and diarrhoea. Additionally, larval stages can be even more dangerous since at the onset of their invasion of the host, the third larval stages (L3) encyst in the gut wall where may cause serious damage to the mucosa. Thousands of encysted larvae may, in turn, cover the wall, severely damaging it and reducing nutritional metabolism.

Anazi and Alyousif (2011) reported that the gastrointestinal tract of horses provides a target site for many internal parasites species such as *Parascaris equorum*, *Gastrophilus spp.* and tapeworms. These parasites have the potential to cause serious diseased condition in horses including diarrhea, emaciation, colic, anaemia, haemorrhage and death.

### 2.3 HAEMATO-BIOCHEMICAL CHANGES
Duncan and Dargie (1975) studied on strongyle infection in the horses and observed most significant haematological changes were an early, sharp rise in WBC, increased neutrophil: lymphocyte ratio and eosinophilia. Marked, progressive increase of total serum proteins as result of betaglobulins occurred.

Duncan and Pirie (1975) reported haemato-biochemical changes associated with single experimental infection of *Strongylus vulgaris* in worm free pony and foals. The most significant haematological findings during the experimental period were a marked polymorphonuclear leucocytosis and an increase in the number of circulating eosinophils in the infected animals. Also, there were marked an increase in the serum globulin levels of the infected foals.

McCraw and Slocombe (1976) studied on *Strongylus vulgaris* in the horse and they found that hemoglobin gm% (Hb gm %), red blood cells per mm$^3$ (RBC/mm$^3$) and packed cell volume (PCV %) may decline slightly indicating a moderate anaemia. The most consistent change in early *S. vulgaris* infection would appear to be a rapid increment in total white cell (WBC) counts. These values have been observed to rise sharply during the first three weeks to levels of 17,000 to 22,700/mm$^3$. Eosinophil values increased after the second week but may show little change in acute infection. Increments in serum total protein and globulin fractions occurred as early as the first week following infection.

Smith (1976) conducted a trial in which five of the seven ponies were reinfected with strongyle and found that no appreciable changes in mean hemoglobin, erythrocyte and packed cell volume values were observed. However, marked increases in the mean eosinophil counts were observed in all reinfected ponies but not in the controls. Sharp increases in eosinophil counts were detected in all ponies within a week of reinfecion and in most instances reached a peak within three weeks. It is noted that pony 3 which received the smallest dose of infective larvae also exhibited relatively smaller elevations in eosinophil counts.

Srihakim and Swerzcek (1978) reported cellular changes in the blood like marked eosinophilia, and leucopenia in foals which were experimentally infected with *Parascaris equorum* for more than 7 days.
Bailey et al. (1984) found increased peripheral blood lymphocytes in *Strongylus vulgaris* infection in horses.

Jasko and Rath (1984) reported hypoalbuminaemia, increased serum globulins in case of cyathostomes (small *Strongyles*) infection in horses.

Hopper et al. (1984) conducted a trial on twelve horses which were divided into three groups and given various doses of a mixed species strongyloide inoculum, representing light, moderate and heavy infection. They recorded six of the twelve animals with strongylosis developed moderate eosinophilia.

Giles et al. (1985) recorded clinical and laboratory findings in a series of 15 cases infected with Cyathostome and found characteristic features included hypoalbuminaemia, increased alpha and beta plasma globulin levels and neutrophilia.

McCraw and Slocombe (1985) studied the pathological effects of *Strongylus equinus* in 17 pony foals and one horse and they found a gradual increase in WBC occurred up to 15 weeks Postinfection (mean at day 0 = 6.8 x 10^9/L, range 4.0-10.0 x 10^9/L, 15 foals; mean at week 15 = 14.0 x 10^9/ L, range 11.4-17.1 x 10^9/ L, 4 foals). Total eosinophils first increased between 2 and 4 weeks Postinfection (mean at week 2 =102 x 10^6/L, range 63-150 x 10^6/ L, 8 foals; mean at week 4 = 299 x 10^6/ L, range 144- 675 x 10^6/ L, 8 foals). A second increment occurred between 13 and 15 weeks Postinfection (mean at week 13 = 340 x 10^6/ L, range 209-450 x 10^6/ L, 4 foals; mean at week 15 = 1952 x 10^6/L, range 1400-2619 x 10^6/L, 4 foals). Total globulin values gradually increased up to the 14-16 week period (mean at day 0 = 26.2 g/L, range 20-33 g/L, 15 foals; mean at week 7 = 41.0 g/L, range 26-67 g/L, 10 foals; mean 14-16 wk = 76.2 g/ L, range 61- 95 g/ L, 4 foals) and remained high for a further 12 week in two foals studied.

Reinemeyer (1986) noted that in equine Cyathostome infection may result in anemia and leukocytosis.

Shalaby (1987) reported mixed infection of *Parascaris equorum*, *Strongyloides westeri*, *Strongylus spp.* and *Oxyuris equi* in 71 of the 140 horses
suffering from diarrhoea in Cairo, Egypt. The blood picture of infected horses revealed eosinophilia and monocytopenia.

Chaudhary et al. (1991) conducted a survey in Faisalabad, Pakistan, based on faecal sample examination and found 40 per cent horses, 35 per cent donkeys and 33 per cent mules to be infected with strongyles. They further reported that blood parameters (TEC, Hb, PCV, TLC and DLC) were low in infected animals compared with uninfected ones. Eosinophilic counts were slightly higher in infected animals.

Dennis et al. (1992) conducted a trial on ten helminth free pony foals and 4 out of 10 pony foals were experimentally infected with 50 *Strongylus vulgaris* infective larvae. Infected pony foals showed eosinophilia, hyperproteinemia, hyperbetaglobulinemia and a reversed of the albumin/globlin (A/G) ratio 4 weeks after initial infection.

Kelly and Fogarty (1993) reported loss of three horses due to larval cyathostomiasis in a thorough bred stud farm in Irish Republic. The animals were less than four years of age and showed that the blood picture revealed leukocytosis and neutrophilia.

Alousi et al. (1994) reported in a survey of parasitic infections in horses in Iraq by faecal and blood examination. They reported 66 per cent as the parasitic infection rate and recorded 11 species of parasites of which six were nematodes and reported a fall in haemoglobin concentration and haematocrit values.

Loon et al. (1995) studied on cyathostome infection in two horses. Blood chemistry revealed hypoalbuminaemia and a low albumin-globulin Ratio.

Murphy et al. (1997) studied on cyathostome associated disease in the horses and observed first case out of 4 cases. They found significant haematological abnormalities included neutrophilia, eosinophilia and hypoalbuminaemia.

Murphy and Love (1997) studied on experimental cyathostome infection in ponies. Nine ponies breed foals were reared indoors, and then infected with third stage cyathostome larvae. Blood biochemical and haematological analyses were
performed weekly. All infected ponies had decreased serum albumin and transient neutrophilia.

Thamsborg (1998) conducted a trial on twelve standardbred foals (age 3-6 months) with little previous exposure to parasites. They found neutrophilia, eosinophilia, anaemia and hyperbeta globulinaemia. Serum albumin and albumin/globulin ratio were reduced.

Love et al. (1999) observed clinical cyathostomosis occurs more commonly in young horses in late winter/early spring but there is lifelong susceptibility to cyathostomes and they can cause clinical disease in any age of horse during any season. Animals with cyathostomasis often develop neutrophilia but there are no clinicopathological features specific for the disease.

Sipra et al. (1999) studied Strongylosis in equines of Faisalabad. They reported low values of TEC, Hb, and PCV in infected untreated animals as compared with those of infected ivermectin treated and significantly higher eosinophil counts in infected untreated animals.

Smets et al. (1999) reported 94 horses which were suspected of being infected with strongylus were examined clinically. Blood samples were monitored for protein, albumin and beta-globulins. They found lower concentrations of total protein and albumin, and with higher percentages of beta-globulin.

Lyons et al. (2000) reported hypoalbuminemia in cases of cyathostomiasis in horses.

Saleem et al. (2000) observed effect of strongylosis on blood parameters. Out of 120 horses 68 were found positive for strongylosis. Haematological parameter showed significant reduction in total erythrocyte count (TEC), haemoglobin (Hb) level and packed cell volume (PCV) while total leukocyte count (TLC) remained within normal limits.

Collobert et al. (2002) collected cyathostomes from naturally infected 42 horses, during December 1998 to March 2000. The effect of age was examined in three subgroups: 6-24-month-old horses, 2-10-year-old horses and horses more than
10 years of age. The main variations were higher eosinophil counts in 6-24-month-old horses and horses more than 10 years of age. Several correlations were found between different cell counts and cyathostome burdens. The numbers of larvae, adult worms, and the total worm burdens were related to eosinophil counts. The relations between cells and worm populations showed variations with age. In 6-24-month-old horses, most of the significant associations were found between eosinophil counts and the total numbers of larvae and worms; in 2-10-year-old horses, they were noticed between the three eosinophil types and the total cyathostome burdens.

Gasser et al. (2004) observed normocytic, normochromic anaemia in horses suffering from strongyloid nematodes.

Hubert et al. (2004) found that Strongylus vulgaris infection resulted in significant increase in total white blood cell counts and plasma protein concentrations while there occurred significant decrease in red blood cell counts and packed cell volume.

Nwosu and Stephen (2005) reported that Gastrodiscus aegyptiacus and Strongyle parasites infected horses had higher packed cell volume (PCV) then uninfected horses.

Peregrine et al. (2006) reported Hypoalbuminemia in larval cyathostominosis in horses. They found decreased levels of serum albumin (range, 11 to 23 g/L; median, 15.5 g/L; reference range, 30 to 37 g/L) and all but 1 had decreased levels of total protein (range, 27 to 53 g/L; median, 39 g/L; reference range, 54 to 75 g/L).

Steinbach et al. (2006) observed effect of small strongyle infection on 24 ponies. They found eosinophilia, monocytosis, increased plasma protein and globulin content.

Mahboob et al. (2008) conducted a trial on horses positive for the strongyloids infestation were randomly divided into six groups A, B, C, D, E and F each comprising of 10 animals. They found horses affected with strongylosis
showed greater reduction in haematological parameter. On day zero total erythrocyte count values were 4.50, 4.09, 3.80, 3.85, 3.87 and 8.00 x 10⁶ /µl in group A, B, C, D, E and F, respectively while on day 7 (post treatment) the values were 4.35, 7.47, 5.02, 6.20, 3.78 and 8.00 x 10⁶ /µl in group A, B, C, D, E and F, respectively. The values on day 14 (post treatment) were 4.25, 9.10, 5.10, 6.80, 3.69 and 8.00 x 10⁶ /µl in group A, B, C, D, E and F respectively. Packed cell volume (PCV) values were 32.50, 31.29, 31.02, 32.80, 32.60 and 37.00% in group A, B, C, D, E and F respectively. The values on day zero (pre treatment) were 31.70, 34.35, 32.10, 36.40, 31.95 and 37.00% in group A, B, C, D, E and F, respectively. The values on day 7 were 31.15, 40.10, 32.12, 39.95, 31.05 and 37.00%, respectively. Haemoglobin estimated values on day zero (pre treatment) in group A, B, C, D, E and F were 8.85, 9.28, 9.35, 9.64, 9.70 and 12.00 g/dl, respectively, while these values in group A, B, C, D, E and F on day 7 (post treatment) were 8.65, 10.35, 9.45, 11.20, 9.18 and 12.00 g/dl, respectively. Similarly the values on day 14 (post treatment) were 8.10, 11.05, 9.49, 12.40, 8.72 and 12.00 g/dl in group A, B, C, D, E and F, respectively.

Rotting et al. (2008) observed the effects of intestinal parasitism on eosinophils in equine large intestinal mucosa. A mixed model analysis was performed and total eosinophil counts and eosinophil distribution in the mucosa were determined. There was no difference in large intestinal mucosal eosinophil counts and eosinophil distribution between ponies infected with S. vulgaris and those raised in a parasite-free environment. Experimental infection with S. vulgaris, with or without subsequent anthelmintic treatment, did not change eosinophil counts, and counts were similar to those for horses from the general population.

Corning (2009) reported typical blood picture in case of small strongyles infection in horses which revealed neutrophilia, hypoalbuminaemia, hyperglobulinaemia especially beta-globulin and serum albumin concentration of less than 20 g/L and a ratio of albumin:globulin of less than 0.7.

Bodecek et al. (2010) examined twelve clinical cases of cyathostomosis in horses treated at the Equine Clinic University of Veterinary and Pharmaceutical Sciences in Brno. They found PCV was elevated in case 4 (0.58 l/l) and decreased in
Eight patients had leucocytosis varying between 14.9–38.0 G/l (cases 1, 3, 4, 5, 7, 8, 9 and 10), one of them had eosinophilia 3% (case 1). Hypoproteinemia was found in four horses (cases 1, 4, 5 and 12; range 31.5–47.3 g/l), hypoalbuniemia in seven horses (cases 1, 4, 5, 8, 9, 10 and 12; range 12.6–21.6 g/l).

Pawlas-opiela et al. (2010) reported that horses were naturally infected with *Gastrophilus spp.* larvae. Mean red and white blood cells counts and mean hemoglobin concentration were significantly lower in *Gastrophilus spp.* infected horses.

### 2.4. THERAPEUTIC EFFICACY OF ANTHELMINTICS

Keli and Torbert (1980) conducted a trial to evaluate the antiparasitic efficacy of ivermectin at dose rate of 0.2 mg/kg against gastrinestinal parasites of horses (ponies). They found 97% efficacy against *Gastrophilus intestinalis* larvae, *Trichostrongulus axei, Oxyuris equi, Strongulus vulgaris, G. nasalis, Parascaris equorum, O. equi, Anoplocephala perfoliata & small strongyles.*

Bello and Norfleet (1981) conducted a controlled critical test method to evaluate the anthelmintic effects of ivermectin given as a single intramuscular injection to 20 naturally parasitized ponies. Dosages tested were 0 (placebo), 200, 300 and 500 µg/kg of body weight. In comparison with necopsy data from the 5 placebo-injected controls, ivermectin treatment at 200 microgram/kg body weight and had 98-100% antiparasite efficacy.

Craig and Kunde (1981) conducted a trial on 12 yearling shetland ponies and treated with injectable ivermectin at dose rate of 200 µg/kg or 300 microgram/kg intramuscular showed reduction in faecal egg counts one week after treatment, were as follows: *Gasterophilus intestinalis* (100%) and (99.9%), *Parascaris equorum* adults (100%), *S. edentatus* adults (100%) and (100%), respectively.

Slocombe and McCraw (1981) conducted study on twelve pony foals were reared worm free and inoculated with *Strongylus vulgaris*. On day 7 after inoculation, 6 ponies were given ivermectin IM at a dose of 200 µg/kg of body weight and on day
28 were necropsied. Ivermectin was effective in eliminating early 4th stage *S. vulgaris* larvae.

Dipietro *et al.* (1982) evaluated the anthelmintic activity of ivermectin in 18 female horses with naturally acquired parasitic infections. Horses were treated once (IM) with vehicle only (n=6), 200 µg/kg of body weight (n=6), and 300 microgram/kg (n=6). Efficacy of both dosages of ivermectin were greater than 99% against *Gasterophilus spp.*, 98% to 99% against adult cyathostome, 86% to 97% against 4th stage cyathostomes and 100% against adult larvae *strongyles*.

Mirck M.H. and Meurs G.K. (1982) conducted study on seven foals were naturally infected with *Strongyloides westeri* were injected intramuscularly with ivermectin at a dose rate of 200 microgram per kg body weight. Weekly faecal egg count showed a greater than 99% reduction of *Strongyloides westeri* egg output compared with 7 untreated foals during the 21 days following treatment.

Slocomb *et al.* (1982) conducted study on twelve pony foals were reared worm free and inoculated with *Strongylus vulgaris*. Approximately 8 weeks after they were inoculated 6 foals were given ivermactin IM at a dose rate of 200 µg/kg of body weight and 6 were given a placebo. All foals were necropsied 35 days after treatment. Ivermectin was 98.9% effective in eliminating later 4th stage *S. vulgaris* larvae.

Schroder and Swan (1982) revealed that parenteral ivermectin administration in horses @ 200 µg/kg body mass is highly effective against the *Strongylus vulgaris, Strongylus edentatus, Triodontophorus* spp., adult and immature *Cyathostomes, Oxyuris equi, Parascaris equorum*, and stomach bots (*Gastrophilus* spp.).

Torbert *et al.* (1982) conducted trial on ponies. They administered ivermectin at dose rate of 0.2 mg/kg. After 14 days of administration of drug they found 98% efficacy on *T. axei, Habronema spp.*, *Strongylus vulgaris, S. edentatus* and small Strongyle species.

Yazwinski *et al.* (1982) conducted a trial for anthelmintic efficacies of the injectable and paste formulations of ivermectin were evaluated in the horse.
Treatment was given at the rate of 200 µg/kg of body weight. Regardless of formulation, 100% removals were demonstrated for *Strongylus vulgaris*, *Strongylus edentatus*, 2\textsuperscript{nd} and 3\textsuperscript{rd} instars of *Gastrophilus nasalis* and *G. intestinalis*.

Klei *et al.* (1984) conducted a trial on pony foals, to evaluate the efficacy of oral paste formulation of ivermectin. They used 0.2 mg/kg ivermectin and ponies were euthanized and necropsied 5 weeks after treatment. They found 90% efficacy of ivermectin against *Strongylus vulgaris*.

Ludwig *et al.* (1984) conducted study on six mares. They were treated on the day of parturition with an intramuscular injection of ivermectin at dose rate of 0.2 mg/kg. Ivermectin administered to mare on the day parturition, and combined with movement to parasite free pastures. They were found significantly lowered the cyathostome (small strongyle) egg production for 4 month.

Slocombe and Cote (1984) conducted study on 26 horses divided in two groups of thirteen horses. They gave ivermectin (0.2mg/kg) orally to one group and left other group untreated. They found Strongyle eggs in the faeces of all horses before treatment but not at two to three weeks after treatment in treated group.

Slocombe J.O. and McCraw B.M. (1984) evaluated efficacy of ivermectin against later fourth-stage *Strongylus vulgaris* larvae in pony foals at 14 and 35 days after treatment. These foals had been reared parasite free, inoculated with 500 infective larvae and 56 days later given either ivermectin at 200 microgram/kg intramuscularly. Ivermectin were found to be highly effective (98.6%) in foals which were examined at 35 days after treatment.

Kohler and Hiepe (1986) evaluated efficacy of ivermectin in *Strongyloides westeri* infection of foals. Ivermecton used as a paste formulation were given to sucking foals and pregnant mares in a single dose of 200 µg/kg body weight by oral administration. They found high efficacy of ivermectin against *strongylaides westeri* infection.

Asquith and Kivipelto (1987) conducted a trial on 120 horses and ponies ranging in age from 142 days to 23 years were used to assess the efficacy and
acceptability of ivermectin liquid for horses when given as an oral drench or by nasogastric intubation. Prior to treatment animals were found to have eggs in the faces of one or more of the following: Strongyle type, *Parascaris equorum* and *Strongyloides westeri*. While egg parasite per gram (EPG) number from 30 untreated controls remained consistently positive over a 14 days period, parasite EPG numbers from animals treated on day 0 were reduced to 0 by day 14 as determined by a modified MC Master technique.

Barragry (1987) reported that ivermectin(oral paste) displays an efficacy in the equine species of greater than 98% against *Gastrophilus* spp., *Trichostrongylus axei*, *Parascaris equorum*, *Oyuris equi*, *Strongylus vulgaris*, *Strongylus edentatus*, *Habronema muscae*, *Draschia megastoma*, *Strongyloides westeri* and *Dictyocaulus arnfieldi*. In the case of *Habronema*, *Draschia* and *Onchocerca* spp. ivermectin exerts a larvicidal action.

French *et al.* (1988) studied the efficacy of ivermectin( in oral paste formulation) @ 200 µg/kg of body weight against naturally acquired larval and adult stages of *Parascaris equorum*, in foals. They observed that ivermectin was 100% effective against lung larval stages and 91% effective against intestinal larvae of *P. equorum* and 93% effective against all intestinal stages.

Daurio and Leaning (1989) found that orally administered ivermectin were 100% effective against experimentally induced 11 day-old infections of *Parascaris equorum* (*L₃*) in 2 trials. In 4 additional trials there was 98% efficacy of ivermectin treatment against induced 28 day old infections of *Parascaris equorum* (*L₄*).

French *et al.* (1989) conducted trial on 21 mixed breed pony foals, reared and maintained under parasite free conditions, to test the efficacy of ivermectin in oral drench and paste formulations (200 µg/kg) against 11 days old migrating larvae of *Parascaris equorum*. Ivermectin in both formulations were 100% effective against *Parascaris equorum*.

Lumsden *et al.* (1989) conducted study they used three anthelmintics pastes in terms of their ability to suppress the output of parasites eggs. Horses were treated once with either ivermectin, fenbendazole and pyrantel. On days 49, 56, 63 and to
the mean egg counts in the ivermectin group were significantly lower (prevalance less than 0.05) than those in either of the other group.

Bell and Holste (1990) conducted a trial on 40 adult and 60 yearling horses to evaluate the efficacy of oral liquid formulation of ivermectin. They found on day 14, fecal ova counts were zero for all horses treated with ivermectin.

Klei et al. (1990) treated 10 pony foals with ivermectin (0.2 mg/kg of body weight) in an oral paste. Ivermectin was effective in reducing S. vulgaris arterial larval and intestinal adult parasite numbers by 100% in foals.

Mogg et al. (1990) administered ivermectin paste @ 200 µg/kg body weight orally in horses. Faecal Strongyle egg counts were performed before and 14th, 28th, 42nd, 56th and 70th day after treatment. They observed that all horses had 0 faecal Strongyle egg counts on 14th and 28th days after ivermectin paste treatment.

Eysker et al. (1991) conducted a trial on two group of three ponies to study the effect of ivermectin or pyrantel treatment given at intervals of 5 weeks at the beginning of the grazing season. Each pyrantel treatment resulted in a > 95% reduction in faecal egg counts during the first 3 weeks.

Lyons et al. (1992) evaluated comparative efficacy of ivermectin (IVE) paste exclusively or alternation of 4 antiparasitic paste compounds: ivermectin (IVE), oxfendazole (OFZ), oxibendazole (OBZ) or pyrantel pamoate (PRT). Every 8 weeks, 1 group of horses (barn C; n=14 to 16) were given ivermectin paste exclusively, and a second group (barn E; n=16) were given the 4 antiparasitic passes on an alternating schedule. For barn-C horses, treated exclusively with ivermectin (200 µg/kg of body weight) 14 times, 2 weeks post treatment mean strongyle egg and small strongyle value were reduced 99 to 100 per cent.

Klei et al. (1993) evaluated efficacy of a high does of ivermectin (1.0 mg per kg eqvalan liquid drench) on encysted cyathostomes in a controlled study using 12 adult ponies with naturally acquired cyathostome infections. They found 99.9% efficacy against adult cyathostomes.
Xiao et al. (1994) evaluated efficacy of moxidectin and ivermectin in four groups of eight ponies with natural parasite infections; placebo (Control), oral moxidectin gel at 0.3 mg/kg of body weight (Mox 0.3), oral moxidectin gel at 0.4 mg/kg of body weight (Mox 0.4) and oral ivermectin paste at 0.2 mg/kg of body weight (Ivermectin). Fecal samples were taken on 0 day and 2 weeks after treatment. Animals were necropsied and worms were collected. Moxidectin and ivermectin showed similar efficacy (99%) against adult cyathostomes, Strongylus spp., Triodontopharus spp and Habronema muscae.

Monahan et al. (1996) evaluated efficacy of moxidectin oral gel and ivermectin oral paste in the control of a spectrum of gastrointestinal parasites of ponies naturally infected in southern Louisianna or Mississippi. Thirty-two mixed-breed ponies ranging in age from one to 21 years was used in this controlled test. A single dose of ivermectin was given orally at dose rate of 200 µg/kg. Ivermectin were more effective against Gastrophilus intestinalis and Anoplocephala perfoliata than moxidectin.

Costa et al. (1998) evaluate the efficacy of ivermectin 24 male and female equines of mixed breed, 10-20 months of age and naturally infected with internal parasites. All horses were administered ivermectin 0.2 mg per kg body weight orally and eggs per gram faeces (EPG) carried out at pretreatment and 3 times post-treatment. The efficacy of ivermectin against immature and adult nematodes was as follows: Parascaris equorum 100%, Strongylus edentatus 100%, S. vulgaris 100%, Strongyloides westeri, 99.2%, and for small Strongyles 99.7% per cent.

Davies and Schwalbach (2000) evaluate defficacy of ivermectin and other anthelmintics under field conditions on 25 horses in the Free State Province of South Africa. In this study, ivermectin was administered @200 µg/kg body weight orally. They observed 100% reduction of Strongyle mean faecal egg count on 14th day of post-treatment.

Klei et al. (2001) conducted two trials to confirm the efficacy of ivermectin paste against endoparasites of horses. In these trials, 20 ponies were treated with ivermectin oral paste at 200 µg/kg body weight once on day 0, and 20 ponies served as unmedicated controls. Ivermectin was highly effective (94% to >99%) against Gastrophilus intestinalis larvae, Habronema spp., Oxyuris equi, Parascaris equorum.
He confirmed that ivermectin paste administered to horses orally at 200 µg/kg continues to be highly effective for treatment and control of a broad range of small and large Strongyle species as well as other species of gastrointestinal parasites of horses.

Deprez and Vercruysse (2003) evaluated efficacy of moxidectin and ivermectin in 20 horses with clinical cyathostominosis were studied during a 3 week observation period. Both treatments were effective in completely eliminating larvae from the faeces within 1 or 2 weeks.

Aftab et al. (2005) evaluated the efficacy of ivermectin at dose rate of 200 µg/kg body weight subcut injection to horses and found 95.17% efficacy against endoparasites.

Hassan et al. (2005) evaluated the efficacy of ivermectin against GIT nematodes and ivermectin treatment was highly effective 88% against all nematode parasites in horses. Ivermectin oral paste at the dose rate of 200 µg/kg body weight once on day 0, was administered in these trials. The data revealed that Ivermectin was highly effective for the treatment and control of a broad range of small and large Strongyle species as well as other species of gastrointestinal parasites.

Toguchi and Chinone (2005) evaluated anthelmintic efficacy of oral paste formulations of ivermectin against gastertointestinal parasites in horses were evaluated, using 15 active racehorses in which nematodes had been detected in their gastrointestinal tracts by faecal examination. A single does of ivermectin were given orally to 12 horses of the treatment group at a dosage rate of 200 µg/kg in order to obtain and identify gasterointestinal parasites in their faeces for 3 days after treatment. Small Strongyles, Strongyles and Parascaris equorum were passed in faeces up to post treatment day 2, but they were no longer observed on post treatment day 3.

Shahardar et al. (2006) conducted study on twelve adult ponies of either sex naturally infected with strongyle worms of various genera were randomly divided into 3 groups of five, five and two animals, that is group I, II and III, respectively. The
animals of group I and II were injected with single dose of ivermectin and doramectin at dose rate of 200 µg/kg S/C, respectively where as group III animals were kept as naturally infected untreated control. Both ivermectin and doramectin were found to be 100% effective against Strongyle worms.

Lind et al. (2007) investigated different aspects on the efficacy of ivermectin and different anthelmintics on Cyathostomin nematodes of Swedish horses (26 farms). All horses were treated with recommended dose of ivermectin (orally) and faecal samples were collected on day of deworming later on 7th, 14th, 21st days, respectively and observed reduction in faecal egg count.

Lyons et al. (2007) conducted parasiticides field study on three thoroughbred horse farms in central Kentucky and treated with ivermectin and other parasiticides periodically. Over a 14-month period, from May 2004 to July 2005, collections (n=989) of feaces were made from the foals for determination of presence of internal parasite eggs/oocysts by qualitative and/or quantitative methods. Based on the percentage of foals with Strongyle-egg-positive feaces and/or the level of eggs per gram of feaces (EPG) counts for the foals after treatment, drug activity on small Strongyles was highest found of ivermectin.

Mahfooz et al. (2008) evaluated efficacy of abamectin against these gastrointestinal parasites with a single shot at the dose rate of 0.2 mg/kg body weight administered through subcutaneous route which resulted in 98% reduction in faecal egg count after day 14 post-treatment.

Lyons et al. (2008) measured the parasiticidal activity of ivermectin and other compounds in horse foals with emphasis on ascarids (Parascaris equorum) in field studies on five farms in Central Kentucky in 2007. Detection of Ascarid and Strongyle eggs in feaces of foals was by a qualitative method (presence or absence) or a quantitative method (eggs per gram of feaces). Efficacy of the ivermectin drug was determined by calculating the average percentage reduction of eggs after vs. before treatment. The efficacy of ivermectin @ 200 µg/kg was tested on three farms; 58 foals were examined, 18 with ascarid eggs (0% red.) and 48 with Strongyle eggs (100% red.) found.
Aldelami and Albadrani (2009) examined 19 fecal samples showed positive results for nematodes (58.0% single and 42.1% mixed infections). The percentage of infestation with *Strongylus* spp., *Oxyuris equi* and *Parascaris equorum* were 31.58%, 15.75%, 10.52%, respectively. Administration of a single dose of a mixture of ivermectin and closantel and found in a significant reduction in average egg count in faeces of the treated horses with both single and mixed infection. The efficacy of mixture of ivermectin and closantel was 100% in removing eggs of *Parascaris equorum* and *Oxyuris equi*, and 99.42% for *Strongylus* spp., at 14 days post treatment.

Bonneau *et al.* (2009) evaluated anthelmintic efficacy of a tablet formula of ivermectin and praziquantel in horses they were experimentaly infected with three species of strongylous larve. Eighteen previously dewormed horses were inoculated on study day 0 with third stage larvae of *Strongylus vulgaris*, *Strongylus equinus* and *Strongylus edentatus*. The horses were randomly allocated to three groups (n=6); test-drug (tablet formula), positive control (reference gel) and negative control (placebo tablet). On days 95 the horses were sacrificed and necropsy examinations were performed to assess the status of the parasite burden and pathological lesions on selected organs and tissue. By the criteria of worm counts, the test drug and positive-control showed respectively 100% and 97.3% anthelmintic efficacies on *S. vulgaris*, 100% and 81.4% on *S. equinus* and equally 100% on *S. edentatus*.

Francisco *et al.* (2009) performed clinical trial for finding efficacy of an ivermectin based pour-on treatment against gastrointestinal parasitic nematodes in naturally infected horses over a 21 week period. The administration of the ivermectin suppressed the egg-elimination of ascarids and pinworms throughout the study and no *Strongyle*-eggs were observed in the treatment group between the 3rd and 10th weeks. The numbers of red cells increased significantly after the anthelmintic therapy, and a statistical reduction in circulating leucocytes was recorded. They concluded that ivermectin formulation was highly successful against gastrointestinal nematodes and appears to be a useful therapeutic routine for horses.

Gokbulut *et al.* (2010) conducted a trial on eighteen female horses. The animals were allocated with three groups (per os, pour-on and intravenous groups). The equine paste, bovine pour-on and bovine injectable formulation of ivermectin
were administered orally, topically and intravenously at the dose rates of 0.2, 0.5 and 0.2 mg/kg body weight, respectively. Ivermectin (paste) reduced the EPG By > 95% for 10 weeks, where as the reduction in pour-on group varied from 82 to 97 percent.

Khan et al. (2010) conducted coprological examination of 150 horse, donkeys and mule in Mona Remount Depot, Sargodha, Pakistan and found 36 per cent prevalence of *Parascaris equorum* in horses. They treated these animals with doramectin and found 92.5 percent final efficacy of treatment with doramectin.

Kornas et al. (2010) evaluated efficacy of ivermectin on 187 foals of a large Polish stud farm and they found 99 per cent efficacy of ivermectin against *P. equorum* was 99% in 82 foals and against 90 per cent for *cyathostomins* in 71 foals.

Lia et al. (2010) studied the efficacy of medicated food pellets (Containing 10mg of ivermectin per kg, UNIFEED, veronesi, verona, Italy) for the control of intestinal strongyles in a group of captive zebras (*Equus burchelli*) at the Satari park, Fasano. The egg reappearance period and the faecal egg counts in terms of egg per gram of faeces were investigated. The drug showed an efficacy of 100% for up to 78 days post treatment with one exception.

Larsen et al. (2011) found that horses treated with ivermectin oral paste at dose rate of 0.2mg/kg showed reduction in faecal egg counts 10-14 days after treatment by 96.9 and 100 per cent for *Parascaris equorum* and *Cyathostomins*, respectively.

Crane et al. (2011) conducted a trial to assess the impact of anthelmintic treatment programme (using oral ivermectin at dose of 0.2mg/kg) on populations of working donkeys, mules and horses in field conditions in Morocco. They found that animals in the treatment group had a significantly lower strongyle worm egg count and increased in body condition score as compared to animals in the control group.
3. MATERIAL AND METHODS

The present study was undertaken to know the prevalence of gastrointestinal parasitism and to record the intensity of gastrointestinal parasites in horses in and around Bikaner. Simultaneously, clinical symptoms and haemato-biochemical alterations were also studied in horses naturally suffering with gastrointestinal parasites. The efficacy of ivermectin was also assessed against gastrointestinal helminthes.

3.1 Animal

One hundred horses irrespective of sex, age and breed were screened for gastrointestinal parasites. These animals were included from the horses brought to the Veterinary Medicine Clinic of College of Veterinary and Animal Sciences, Bikaner, nearby villages like Udasar, Nokha, Poonrasar, Shri Kolayat, Ganashahar, Khara Village, as well as horses belonging to individual holdings in and around Bikaner.

3.2 Feeding

All the animals included in the present study were stall fed. They were fed with concentrate comprising of Gram, Bajara and Barley etc and roughages sewan grass, wheat bran and groundnut fodder.

3.3 Parasitological examination

3.3.1 Collection of faecal samples:

Faecal samples (3 or 4 pellets per horse) were collected per rectum from horses at morning hours in individually labeled polythene bags and kept in refrigerator as described by Hansen and Perry (1990). The faecal samples were collected to study the prevalence and intensity of gastrointestinal helminthes in and around, Bikaner.

3.3.2 Examination of faecal samples:
The faecal samples were examined qualitatively as well as quantitatively on the day of collection.

3.3.2.1 Qualitative method of faecal examination:

The qualitative methods of faecal examination were conducted to record the prevalence of gastrointestinal helminthes infestation in horses in and around, Bikaner district on the basis of presence of helminthes eggs. The faecal samples were examined by using the following techniques.

1. Direct smear technique.
2. Sedimentation technique.
3. Willi’s floatation technique.

3.3.2.1a Direct smear technique:

A small quantity of faeces was taken with the help of an applicator stick on a glass slide and mixed with 3-4 drops of water and covered with cover slip and examined under low power microscope (10x) to demonstrate the presence of helminthes eggs.

3.3.2.1b Sedimentation technique:

Few pellets of faeces (1-2 gram) were taken in a mortar and emulsified in 10-15 ml of water with the help of pestle. The emulsion was strained through a sieve to remove all the coarse particles and was centrifuged at 1000 rpm for 3 minutes. The supernatant fluid was then decanted and drop of sediment was taken on a clean glass slide, mixed with 1-2 drops of water, covered with cover slip and examined under low power objective (10x) of the microscope to demonstrate the presence of helminthes eggs particularly the trematode eggs.

3.3.2.1c Willi’s floatation technique:

A thick mixture of 1-2 gram of faeces in water was made with help of mortar and pestle. This mixture was filled in a small vertical floatation tube (7.5 cm x 2.5 cm) having flat bottom, up to the level of one third. The tube was then filled to its capacity
with saturated sodium chloride solution taking care to avoid overflow of contents of tube. A clean micro glass slide was kept over the tube in manner that it was in contact with the fluid. The tube was allowed to stand for half an hour so that all the eggs could be floated up. The slide was removed quickly and after putting a cover slip it was examined under low power objectives (10x) of the microscope.

3.3.2.2 Quantitative method of faecal examination:

The quantitative faecal examination was carried out to record the intensity of gastrointestinal helminthes eggs in the known weight of the faecal sample. The intensity of infection was calculated by counting the number of eggs per gram of faeces of individual horse.

3.3.2.2a. Determination of eggs per gram (EPG) of faeces:

The intensity of gastrointestinal parasites eggs was recorded by modified McMaster technique as described by Coles et al., (1992). Three gram of faeces were taken in a mortar and to this 42 ml of water added and soaked for a few minutes and emulsified with the help of a pestle. Emulsion was centrifuged at 1500 rpm for 5 minutes. The supernatant was gently poured off. The tube was agitated to loosen the sediment and saturated sodium chloride solution was added to make final volume up to 15 ml. The tube was inverted five to six times and the chamber of McMaster slide was charged with this sample. Repeating the process of inversion of tube another chamber of McMaster slide was also charged with the help of pasteur pipette. Eggs were counted under the low power objective of a microscope (10x) in two ruled areas consisting of a total volume 0.3 ml. The number of eggs counted was multiplied by 50 to get eggs per gram of faeces (EPG).

Eggs per gram (EPG) of faeces = No of eggs in two chambers × 50

(Where; 50 is dilution factor)

3.4 Collection of blood samples
After clinical examination of the animals, blood samples were collected from jugular vein with all aseptic precautions in sterilized test tubes. For haematological studies, blood was collected in sterile tubes having disodium salt of ethylene diamine tetra acetic acid (EDTA) as an anticoagulant added at the rate of 1 mg/ml of blood as recommended by Jain (1986).

For biochemical studies, blood was collected in other sterile tubes having no anticoagulant. The blood slants were made and incubated for 1 hour at 37°C. Blood clots were broken and tubes were centrifuged at 2,500 rpm for 30 min. The serum was pipetted out in small pyrex tubes and was kept immediately in the deep freeze at −20°C till analysis.

3.4.1 Haematological examination

The blood samples were subjected for estimation of haemoglobin, packed cell volume, total erythrocytes count, total leucocytes count, total eosinophil count and differential leucocytes count. These parameters were analyzed as per the methods described by Jain (1986).

3.4.1.1 Haemoglobin (Hb)

Haemoglobin was determined by Sahli-Hellige haemoglobinometer. Blood was drawn in Sahli’s pipette up to 20 cubic millimeter mark. It was then transferred to haemoglobinometer tube containing 4-5 drops of 0.1N hydrochloric acid and mixed well. The tube was then kept for 5 minutes for the haemoglobin to change into acid haematin. The fluid was diluted with distilled water drop by drop and mixing after each drop until it matched to the colour of the standard comparison tubes. The haemoglobinometer tube was read to give the amount of haemoglobin in g/dl of the blood.

3.4.1.2 Packed cell volume (PCV)

For determination of packed cell volume, microhaematocrit method was adopted. Non-heparinized capillary tubes were filled with blood up to three-fourth of total length. The blood adhered over the end of capillary tubes was wiped off with the help of a moist filter paper. The opposite ends of tubes were sealed over the spirit
lamp by rotating between the thumb and the index finger for 2-3 seconds over the flame near its base. After perfect sealing of the end, the tubes were centrifuged for 5 minutes at 12,000 rpm in microhaematocrit centrifuge machine.

After centrifugation, packed cell volume was determined with the help of a special microhaematocrit reader scale. The bottom of the red column of capillary tube was adjusted with the zero line and the plasma level was matched with the hundred lines and top of red column excluding buffy layer was read in per cent.

### 3.4.1.3 Total erythrocytes count (TEC)

The RBC pipette was filled up to 0.5 mark with the blood. The diluting fluid (Hayem’s fluid) was drawn up to 101 mark. After shaking the pipette for the three minutes, the fluid in its stem was discarded. The counting chambers of the haemocytometer were carefully charged with the diluted blood after placing a cover slip. It was ensured that blood cells were evenly distributed over the counting chamber and overloading was avoided. The red blood corpuscles present in the four corner small squares and one small central square of the large central square were counted under high power of the microscope.

**Calculations**

Numbers of red blood cells per cubic millimeter were calculated after multiplying the number of cells counted by 10,000 according to be following formula:

\[
\text{Total erythrocytes} = \text{Cells counted} \times 200 \times 10 \times 5 \text{ per cubic mm}
\]

Where:

200 stands for dilution

10 stands for depth in mm

5 stands for the 1/5\(^{th}\) of square millimeter counted

### 3.4.1.4 Total leucocytes count (TLC)
The WBC pipette was filled up to 0.5 mark with blood and the WBC diluting fluid was drawn up to 11 mark. After shaking the pipette for three minutes, the fluid in its stem was discarded. Counting chamber of the haemocytometer was carefully charged with diluted blood after placing cover slip. The cells were counted under low power of the microscope in the large four corner squares of the haemocytometer.

**Calculations**

The numbers of leucocytes in one cubic millimeter of blood were calculated by multiplying the total leucocytes counted by factor 50, according to the following formula:

\[
\text{Cells counted} \times 20 \times 10
\]

\[
\text{Total leucocytes per cubic mm} = \frac{\text{Cells counted} \times 20 \times 10}{4}
\]

Where:

- 20 stands for dilution.
- 10 stands for depth in mm.
- 4 stands for the number of square millimeters counted.

**3.4.1.5 Differential leukocyte count (DLC)**

Thin smears of blood were prepared on dust, lint and grease free clean microscopic slides, immediately after the collection of blood and were air dried. These were then fixed for five minutes with methyl alcohol (methanol). The slides were dried and placed on a staining rack and flooded with Giemsa’s stain (BDH) freshly diluted in the ratio of 1:10 and allowed to act for 30 minutes. The slides were washed with neutral distilled water, air dried and examined under oil immersion lens of the microscope for differential leukocyte count. One hundred cells were counted. Neutrophils, lymphocytes, monocytes, eosinophils and basophils were differentiated and expressed in per cent.
3.4.1.6 Total eosinophil count

It was done by Pilot’s method as presented by Darnody and Davenport (1958) as follows.

**Principle**

A diluting fluid for eosinophil count, propylene glycol was employed to lyse all the leucocytes except the eosinophils.

**Reagent**

Composition of diluting fluid (pilot’s)

- Propylene glycol 50 ml
- Distilled water 40 ml
- Phloxine (1% aqueous solution) 10 ml
- Na₂CO₃ (10% aqueous solution) 1 ml

Mix and filter after which the solution is stable at room temperature for at least one month.

**Procedure**

The blood was drawn up to 1.0 mark in the white blood count pipette (WBC). It was diluted with Pilot’s fluid up to 11 mark. The pipette was shaken for 5 minutes in a pipette shaker. Then it was kept for an hour for completing the lysis of all the cells except eosinophils. After charging the haemocytometer the eosinophil count was carried out under low power of microscope in all nine chambers.

**Calculation**
3.5 Biochemical estimation

Biochemical analysis of serum samples was done to estimate total protein and albumin. Determination principle, reagents required, procedure, calculation and precautions used for each of them are described below:

3.5.1 Determination of total protein

Total protein in serum was estimated colorimetrically by using kit supplied by (Span Diagnostics Ltd., India) as per modified Biuret and Doumas method (Doumas et al., 1981).

**Principle**

Cupric ions of biuret reagent form chelates with peptide bond of proteins in an alkaline medium to form a blue purple complex. Sodium potassium tartarate keeps the cupric ions in solution. The intensity of the blue purple color that is formed is proportional to the number of peptide bonds which, in turn, depends upon the amount of proteins in the specimens.

**Reagents required**

1. Biurate reagent- 3 gm of copper sulphate was dissolved in 1500ml of distilled water. To it 9 gm of Sodium potassium tartarate and 5 gm of potassium iodide were added and mixed. Then 24 gm of sodium hydroxide dissolved separately in 100 ml of water was added to it.

2. Protein standard- total protein count of pooled serum was determined Kjeldhal method and calibrated against a controlled serum having a known protein concentration. Protein standard contained total protein concentration of 7 gm per 100 ml of serum.

**PROCEDURE**

Three test tubes were marked as blank (B), standard (S) and test (T). 5 ml of modified biurate reagent was measured into each of the tube. 0.1ml of serum into test, 0.1ml of protein standard into standard and 0.1ml of distilled water into blank were added, mixed well and allowed to stand at room temperature for 5 minutes. Optical density (OD) of standard (S) and test (T) were measured on a colorimeter against blank (B) with yellow green filter (550 nm).

**Calculations:**
Total serum protein in (gm/100 ml) = \frac{O.D\text{ (test)}}{O.D\text{ (standard)}} \times \text{Concentration of total protein in standard (gm/100ml)}

= \frac{O.D\text{ (test)}}{O.D\text{ (standard)}} \times 7.0

Precautions:

1. Haemolysed serum samples were discarded.
2. Glassware was thoroughly washed, rinsed with distilled water and perfectly dried.
3. All the reagents were brought to room temperature before use.

3.5.2 Determination of albumin

Serum albumin was determined using kit as per bromocresol green (BCG) dye binding method (Doumas et al., 1971).

Principle

Binding of a protein to an indicator changes its colour. Among serum protein, only albumin in serum binds with the dye bromocresol green (BCG) at PH 4.2, to form a green colored complex, which is measured colorimetrically. The PH is maintained during the reaction by a buffer.

Reagents required

1. Succinate buffer- 11.8 gram of succinic acid are dissolved in about 800 ml of distilled water. The pH was adjusted to 4.0 with 0.1 N sodium hydroxide. The volume was made up to 1 liter with distilled water. The solution was stored in refrigerator.

2. Bromocresol green (BCG) solution- 419 mg of bromocresol green was dissolved in 10 ml of 0.1N sodium hydroxide solution. The volume was made up to 1 liter with distilled water. The solution was stored in refrigerator.

3. Buffered BCG dye reagent- 250ml solution was mixed with 750ml of succinate buffer. The pH was adjusted to 4.2 with 0.1N sodium hydroxide solution and then 4ml of Brij-solution (30%) was added.
4. Standard albumin solution- an aqueous solution of albumin with a concentration of 3.9gram/100ml of serum was prepared and used as a standard.

**PROCEDURE**

Three tubes were marked as blank (B), standard (S) and test (T). 4 ml of buffered dye reagent was measured into each of the tube. 0.03 ml of serum in test, 0.03 ml of standard albumin in standard and 0.03 ml of distilled water in blank were added, mixed well and allowed to stand at room temperature for 1 minute. Optical density (OD) of standard (S) and test (T) were measured on a colorimeter against blank (B) with a yellow red filter (600 nm).
Calculations:

\[
\text{Serum albumin in (gm/100ml)} = \frac{\text{O.D (test)}}{\text{O.D (standard)}} \times \text{Concentration of albumin in standard (gm/100ml)}
\]

\[
= \frac{\text{O.D (test)}}{\text{O.D (standard)}} \times 3.9
\]

Precautions:

1. Haemolysed serum samples were discarded.
2. Glassware was thoroughly washed, rinsed with distilled water and perfectly dried.
3. All the reagents were brought to room temperature before use.

3.5.3 Determination of Globulin:

Serum globulin was estimated in gm/100ml as a difference between total protein and albumin, which were estimated as per the modified Biurate and Doumas method (Doumas et al., 1981) and Bromocresol green dye binding method (Doumas et al., 1971).

\[
\text{Serum Globulin (gm/100ml)} = \text{Total serum protein in (gm/100ml)} - \text{Albumin in (gm/100ml)}
\]

3.5.4 Determination of albumin globulin ratio:

Albumin and globulin ratio (A:G) was derived after dividing concentration of albumin by concentration of globulin, in g/100 ml.

3.6.1 Therapeutic trial
A total of 100 horses irrespective to age, sex, breed were screened for gastrointestinal parasites and out of these 20 positive cases of gastrointestinal parasitism were selected for treatment. The treatment was administrated after completion of faecal examination.

Animals were administrated orally tablet ivermectin @ 200 μg/kg body weight as a single dose (Virbac, Animal Health India Pvt. Ltd., Mumbai, each tablet contains 80 mg ivermectin I.P.).

After administration of drug in each positive animal, faecal sample were again collected on 15\textsuperscript{th} day for EPG count to note the efficacy of drug.

### 3.6.2 Evaluation of anthelmintic efficacy

A total of 100 horses were randomly selected with irrespective to age, sex, breed and out of these positive cases were selected for efficacy trial. The faecal sample was examined for the presence of infection and intensity of gastrointestinal parasitic load in term of eggs per gram of faeces (EPG). The efficacy of ivermectin was evaluated in natural gastrointestinal parasitic infestation of horses.

The evaluation of efficacy of anthelmintic drug was done strictly on the basis of WAAVP guidelines as described by Wood \textit{et al.} (1995) by comparing the mean EPG values before and after treatment.

\[
\text{Efficacy of treatment} = \frac{\text{Mean EPG value before treatment} - \text{Mean EPG value after treatment}}{\text{Mean EPG value before treatment}} \times 100
\]

### 3.7 Statistical analysis

The data obtained in research work undertaken were statistically analysed and compared as per the standard statistical procedure suggested by Sendecor and Cochran (1994) and significance of mean difference were tested by “T” test.
4. RESULTS AND DISCUSSION

The helminths are the most common gastrointestinal parasites of horses. Their presence in the animal causes huge amount of economic losses to the owner. Accordingly considerable resources are directed towards their control. The losses due to latent infection are manifested in many ways. In heavy infestation, the mortality rates rises causing of economic losses. It was found that the horses in Bikaner region were mainly depending on stall-feeding. The main aim was to study the pattern of gastrointestinal parasites in horses in and around Bikaner.

One hundred horses irrespective of sex, age and breed were screened for gastrointestinal parasitism. A total of 20 positive cases for gastrointestinal parasitism (Plate 2) were selected for treatment irrespective of sex, breed and age. Ten apparently healthy horses (Plate 1) free from any parasitic infestation, were also selected from various places of Bikaner for study of haematological and biochemical examination to serve as control.

4.1 Prevalence

A total of 100 faecal samples of horses were examined for gastrointestinal parasitism. The results are presented in figures 1, 2 and plates 3, 4, 5, 6.

During the present investigation, it was found that overall 39% of horses of different areas in and around Bikaner were suffering from gastrointestinal parasitism. Thus the prevalence of gastrointestinal parasites in horses has been recorded earlier by many workers. It has been reported by Papazahariadou et al., 2009 (34.5%), Piskin et al., 1999 (42%), Islam, 1986 (53.09%) and Alousi et al., 1994 (66%) respectively.
In present study *Strongyle spp.* showed the highest prevalence 71.79 per cent. Highest prevalence of *Strongyle spp.* in the present study is in accordance with 63.75% (Konigova *et al.*, 2001); 71% (Aydenizoz 2004); 71.0% (Gawor *et al.*, 2006); 71.76% (Bakirci *et al.*, 2004), respectively.

The prevalence of *Parascaris equorum* 20.51 per cent recorded in the present study. The prevalence of *Parascaris equorum* in the present study is similar with 20.3% (Itagaki *et al.*, 1993); 21.95% (Paudel, 2007); 22.82% (Altas *et al.*, 2007), respectively.

The prevalence of *Oxyuris equi* 12.82 per cent recorded in the present study. The prevalence of *Oxyuris equi* in the present study is similar with 9.40% (Pandit *et al.*, 2008); 12% (Mahfooz *et al.*, 2008); 13.45% (Islam, 1986), respectively.

The prevalence of *Anoplocephala spp.* 7.69 per cent recorded in the present study. The prevalence of *Anoplocephala spp.* in the present study is similar with 8.14% (Pandit *et al.*, 2008); 9.8% (Rehbin *et al.*, 2002), respectively.

The prevalence of *Triodontophrous* 7.69 per cent recorded in the present study. The prevalence of *Triodontophrous* in the present study is similar with 10.4% (Poynter, 1970); 15.5% (Altas *et al.*, 2007), respectively.

The prevalence of *Strongyloides westeri* 5.12 per cent recorded in the present study. The prevalence of *Strongyloides westeri* in the present study is similar with 5.14% (Mundim *et al.*, 2000); 5.8% (Gul *et al.*, 2003), 6.19% (Pandit *et al.*, 2008), respectively, in horses.

The prevalence of *Habronema* 5.12 per cent recorded in the present study. The prevalence of *Habronema* in the present study is similar with 3.33% (Katoch *et al.*, 2006), 4.87% (Paudel, 2007), respectively.
Fig. 1 - Overall Prevalence (%) of Gastrointestinal Parasitic infestation in horses.

Fig. 2 - Species wise prevalence (%) of Gastrointestinal parasites in horses.

- Strongyle spp.
- Parascaris equorum
- Oxyuris equi.
- Anoplocephala spp.
- Triodontophorus
- Strongylodies westeri
- Habronema
- Eimeria leuckarti
The prevalence of protozoa *Eimeria leuckarti* 2.56 per cent recorded in the present study. The prevalence of *Eimeria leuckarti* in the present study is similar with 1.41% (Sengupta and Yadav, 1998), 5.88% (Bakirci et al., 2004), respectively.

Season and climatic condition like humidity, temperature availability of vectors for parasites play an important in the prevalence of parasites (Gundach et al., 2004). The effect of dry and wet climate on the prevalence of parasites has been reported (Chaudri et al., 1985). The prevalence of gastrointestinal parasites is related to the agro-climatic condition like quantity and quality of pasture, temperature, humidity and grazing behavior of the hosts. The incidence of nematodes in an area is directly related to the ability of the pre-parasitic stages to withstand the environmental condition (Fatima et al., 2007).

In horses lower infection rates have been recorded because regular deworming practices with effective drug are routinely undertaken (Capewall et al., 2005).

### 4.2 Clinical Signs

Common clinical signs recorded in horses infested with gastrointestinal parasites included weakness, dullness, anorexia, diarrhoea, rough hair coat, loss of body weight, anaemia, poor body condition, eating of inanimate objects, loss of vigour and reduced in work performance. It was also noticed that few moderately infested horses suffered from poor appetite and general weakness. In heavy infestation horses suffered from pyrexia, colic and lameness. The horses with greater than 1000 EPG showed loss of body weight, anorexia, anaemia and colic.

The clinical signs observed in the present study were also similar with, like anaemia, colic, diarrhoea (Anazi and Alyousif, 2011) (Saeed et al., 2010), (Hassan et al., 2005), (Jasko and Roth, 1984); lethargy, weight loss (Corning, 2009) (Umur and Acici, 2009) (Traversa, 2010); reduced work performance (Nwosu and Stephen, 2005); anorexia (Duncan and Pirie, 1975), (Boyle and Houston, 2006) and lameness (Hassan et al., 2010), (Gasser et al., 2004).

The small strongyles play a relevant pathogenic role in horses, causing clinical signs like lethargy, sudden weight loss, debilitation, and diarrhoea. Additionally, larval stages can be even more dangerous since at the onset of their invasion of the host, the third larval stages (L3) encyst in the gut wall where may cause serious damage to the mucosa. Thousands of encysted larvae may, in turn, cover the wall, severely damaging it and reducing nutritional metabolism (Traversa, 2010). The L4s and L5s of *strongylus vulgaris* migrate through the arterial system and causes 'Verminous arteritis'. Thrombus formation can block arteries causing
infarction of intestinal walls and intermittent lameness, and in commonly associated
with clinical signs of marked pyrexia, anorexia, and severe colic (Gasser et al.,
2004).

4.3 Faecal eggs count

The mean ± SE value and range of faecal egg count (eggs per gram of
faeces) of different faecal samples of gastrointestinal parasites infested horses have
been presented in Table 1 and Appendix X

Table 1: Mean ± SE value of faecal egg count (egg per gram of faeces) of
gastrointestinal parasites infested horses.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infested Horses</td>
<td>825 ± 58.77</td>
<td>500-1600</td>
</tr>
</tbody>
</table>

The overall mean value of eggs per gram (EPG) of faeces in 20 horses
affected with gastrointestinal parasites in the present study were 825 with a range of
500-1600 whereas, apparently healthy horses did not show any parasite and
protozoa in faecal examination.

The findings of present study were similar to that of Upjohn et al. (2010). They
recorded gastrointestinal parasites infestation intensity as low (1-500 eggs per
gram), medium (501-1000 eggs per gram) and high (more then 1000 eggs per
gram). Similar findings have been reported by Sipra et al., (1999); Umur and Acici

The differences in intensity of infection could be due to variations in
parasite biology relating to climatic conditions, pasture infection intensity
relating to grazing practices and/or differences in use of anthelmintics (Upjohn
et al., 2010). A study by Getachew et al., (2008) which looked at faecal egg count in
horses over a period of 2 years in Ethiopia confirmed that counts were highest in the
long rainy season as compared to the dry season.

4.4 Haematological parameters

4.4.1 Haemoglobin (gm%)

The mean ±SE value and range of hemoglobin of apparently healthy and
gastrointestinal parasites infested horses have been presented in Table 2, Appendix
II, VI, and depicted in Figure 3.
Table 2: Mean ± SE value of haemoglobin (Hb) of apparently healthy and gastrointestinal parasites infested horses.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently healthy</td>
<td>12.2 ± 0.32 b</td>
<td>10-15</td>
</tr>
<tr>
<td>Infested Horses</td>
<td>8.9 ± 0.49 a</td>
<td>6.8-11</td>
</tr>
</tbody>
</table>

Different superscripts differ significantly (P< 0.01)

The mean ±SE value of haemoglobin of apparently healthy horses and gastrointestinal parasites infested horses were 12.2 ± 0.32 and 8.9 ± 0.49 gm%, respectively.

The mean value of haemoglobin of gastrointestinal parasites infested horses was found significantly low (P< 0.01) when compared to mean value of apparently healthy horses.

The finding of present study is in conformity with the findings of Saleem et al. (2000); Pawlas-opiela et al., (2010). They recorded significant reduction in haemoglobin in gastrointestinal parasites infested horses. The findings of present study are also similar to that of Chaudhary et al., (1991); Alousi et al., (1994); Sipra et al., (1999); and Mahboob et al., (2008). They reported reduction in haemoglobin level in gastrointestinal parasites infested horses.

A significant decrease in haemoglobin was seen in some infected animals producing a state of anaemic condition. Haemoglobin level was as low Similar, Chaudhri et al., (1991); Srihakim and Swerczek (1978). The decrease in haemoglobin was associated to the nature of helminthes, particularly strongyles, which are known as blood suckers. Heavy worm loads (strongyles) generally lead to anaemia and it’s caused by both migrating larvae and adult worms. The larva causes anemia by inducing haemorrhagic tracts in the liver parenchyma during migration and also by producing nodules in the wall of caecum and colon. On rupture of these nodules considerable bleeding takes place. Similarly, the adults suck considerable amount of blood causing anemia (Radostits et al., 2007).

4.4.2 Packed cell volume (%)

The mean ± SE value and range of pack cell volume of apparently healthy and gastrointestinal parasites infested horses have been presented in Table 3, Appendix II, VI, and depicted in Figure 3.

Table 3: Mean ± SE value of packed cell volume of apparently healthy and gastrointestinal parasites infested horses.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SE</th>
<th>Range</th>
</tr>
</thead>
</table>


The mean ± SE value of packed cell volume of apparently healthy horses and gastrointestinal parasites infested horses were 34.6 ± 1.52 and 28.3 ± 0.96 %, respectively.

The mean value of packed cell volume of gastrointestinal parasites infested horses were found significantly low (P< 0.01) when compared to mean value of apparently healthy horses.

The findings of present study were similar to that of Saleem et al., (2000) and Mahboob et al., (2008). They recorded significant reduction in packed cell volume in gastrointestinal parasites infested horses. The findings of present study are also similar to that of Hubert et al., (2004); Chaudhary et al., (1991); Sipra et al., (1999). They reported reduction in packed cell volume in gastrointestinal parasites infested horses.

The decrease values of PCV in present study could be accounted to direct loss of whole blood due to blood sucking activities and concurrent haemorrhages produced by these gastrointestinal nematodes (Soulsby,1982).

### 4.4.3 Total erythrocyte count (million/cumm)

The mean ± SE value and range of total erythrocyte count of apparently healthy and gastrointestinal parasites infested horses have been presented in Table 4, Appendix II, VI, and depicted in Figure 3.

<table>
<thead>
<tr>
<th>Parameter Group</th>
<th>Mean ± SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently healthy</td>
<td>7.88 ± 0.24 b</td>
<td>6.90-9.50</td>
</tr>
<tr>
<td>Infested Horses</td>
<td>6.08 ± 0.12 a</td>
<td>5-7.20</td>
</tr>
</tbody>
</table>

Different superscripts differ significantly (P< 0.01)

The mean±SE values of total erythrocyte count of apparently healthy horses and gastrointestinal parasites infested horses were 7.88±0.24 and 6.08±0.12, million/cumm, respectively.
The mean values of total erythrocyte count of gastrointestinal parasites infested horses were found significantly low (P< 0.01) when compared to mean value of apparently healthy horses.

The findings of present study were similar to that of Saleem et al., (2000) and Hubert et al., (2004). They recorded significant reduction in total erythrocyte count in gastrointestinal parasites infested horses. The findings of present study were also similar to that of Chaudhary et al., (1991); Sipra et al., (1999); Mahboob et al., (2008); Pawlas-opiela et al., (2010). They reported reduction in total erythrocyte count in gastrointestinal parasites infested horses.

The decreases values of Hb, PCV and TEC in present study could be accounted to direct loss of whole blood due to blood sucking activities by these gastrointestinal nematodes. Peal et al., (1989) and Sohail (1989) reported that there is decrease in haemoglobin level, total erythrocyte count and packed cell volume as compared to healthy animals. It is tempting to speculate that the decrease in haematological values may be due to the blood sucking nature of the parasite.

4.4.4 Total leucocytes count (thousands/cumm)

The mean ± SE value and range of total leucocyte count of apparently healthy and gastrointestinal parasites infested horses have been presented in Table 5, Appendix II, VI, and depicted in Figure 3.

Table 5: Mean ± SE value of total leucocytes count of apparently healthy and gastrointestinal parasites infested horses.

<table>
<thead>
<tr>
<th>Parameter Group</th>
<th>Mean ± SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently healthy</td>
<td>8.94 ± 0.33</td>
<td>7.5-11</td>
</tr>
<tr>
<td>Infested Horses</td>
<td>9.70 ± 0.26</td>
<td>8.20-12</td>
</tr>
</tbody>
</table>

The mean±SE value of total leucocyte count of apparently healthy horses and gastrointestinal parasites infested horses were 8.94 ± 0.33 and 9.70 ± 0.26, th/cumm, respectively.

The mean value of total leucocyte count of gastrointestinal parasites infested horses were showed non significant increase when compared to mean value of apparently healthy horses.

The findings of present study were similar to that of Kelly and Fogarty (1993) and Bodecek et al., (2010). The findings of present study are also similar to that of Duncan and Dargie (1975); McCraw and Slocombe (1976); McCraw and Slocombe (1985). The finding is however, contrary to Chaudhary et al., (1991); Pawlas-opiela et al., (2010); Saleem et al., (2000). They found decrease value of total leucocyte count in gastrointestinal parasites infested horses.

In the present study non significantly increase values of total leukocyte count in gastrointestinal parasites infested horses could be due to localized helminthes infestations and secondary bacterial infection of gastrointestinal tract of horses as
sated by Benzamin (1985). This may also be due to increase in number of eosinophils which has resulted from local immune response (Dawakins et al., 1989).
4.4.5 Differential leucocyte count (%)

The mean ± SE values of differential leucocyte count of apparently healthy and gastrointestinal parasites infested horses have been presented in Table 6, Appendix III, VII and depicted in Figure 4.

Table 6: Mean ± SE value of differential leucocyte count of apparently healthy and gastrointestinal parasites infested horses.

<table>
<thead>
<tr>
<th>Group</th>
<th>N%</th>
<th>L%</th>
<th>M%</th>
<th>E%</th>
<th>B%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently healthy</td>
<td>49.8 ± 0.53</td>
<td>44.7 ± 0.49&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.3 ± 0.21</td>
<td>2.3 ± 0.21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.6 ± 0.26</td>
</tr>
<tr>
<td>Infested Horses</td>
<td>51.15 ± 0.53</td>
<td>41.6 ± 0.56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3 ± 0.27</td>
<td>3.8 ± 0.23&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.7 ± 0.18</td>
</tr>
</tbody>
</table>

Different superscripts differ significantly (P < 0.01)

Neutrophil count (%)

The mean ± SE value of neutrophils of apparently healthy horses and gastrointestinal parasites infested horses were 49.8 ± 0.53 and 51.15 ± 0.53 percent, respectively.

The mean value of neutrophils of gastrointestinal parasites infested horses showed non significant increase when compared to mean value of apparently healthy horses.

The findings of present study were similar to that of Giles et al., (1985); Kelly and Fogarty (1993); Murphy et al., (1997); Thamsborg et al., (1998); Love et al., (1999); Corning (2009). They found increase value of neutrophils in gastrointestinal parasites infested horses.

Neutrophils are actively amoeboid and phagocytic. They engulf foreign particles and bacteria and generally digest them. Neutrophils manufacture a trypsin-like enzyme with which they digest the bacteria and dead tissue. When the bacteria invade the body, the leucocytes pass out of the blood vessels and surround the threatened area and through their pseudopodial process engulf the bacteria and destroy them through the phagocytic action of neutrophils may thus be correlated with their increase number in the present study.

Lymphocyte count (%)

The mean ± SE value of lymphocytes of apparently healthy horses and gastrointestinal parasites infested horses were 44.7 ± 0.49 and 41.6 ± 0.56 percent, respectively.
The mean ± SE value of lymphocytes of gastrointestinal parasites infested horses were found significantly low (P< 0.01) when compared to mean value of apparently healthy horses.

The finding of present study was almost similar with the Sena et al., (2000). They reported decreased lymphocytes in camels suffering from gastrointestinal nematodes. Blackburn et al., (1992) reported low values of lymphocyte in goat. Ghulam Rasool et al., (1995) and Mishra et al., (1996) reported low values of lymphocyte in sheep.

**Monocyte count (%)**

The mean ± SE value of monocytes of apparently healthy horses and gastrointestinal parasites infested horses were 2.3±0.21 and 3±0.27 per cent, respectively.

The mean value of monocytes of gastrointestinal parasites infested horses showed non significant increase when compared to mean value of apparently healthy horses.

The finding of present study is almost similar with the Steinbach et al., (2006) in ponies and Mishra and Ruprah (1972) in sheep but contrary to the finding of Shalaby (1987) in horses and Blackburn et al., (1992) in goat. They found no significant change in the monocytes value of gastrointestinal parasites infested animals.

Monocytes are capable to phagocytising and digesting the particulate matter, such as cellular debris (Tompkins, 1955). Their functions thus explain the rise in their number in gastrointestinal parasites infested animals.

**Eosinophil count (%)**

The mean ± SE value of eosinophils of apparently healthy horses and gastrointestinal parasites infested horses were 2.3±0.21 and 3.8±0.23 per cent, respectively.

The mean ± SE value of eosinophils of gastrointestinal parasites infested horses were found significantly increase (P< 0.01) when compared to mean value of apparently healthy horse

The finding of present study is in conformity with the findings of Murphy et al., (1997); Sipra et al., (1999). They recorded significantly increase in eosinophils in gastrointestinal parasites infested horses. The findings of present study are also similar to that of Hopper et al. (1984); Shalaby (1987); Duncan and Dargie (1975); Srihakim and Swerzcek (1978); Thamsborg (1998). They recorded increase in eosinophils in gastrointestinal parasites infested horses.

Eosinophils play a definite role in the development of immunity and phagocytosis of the antigen-antibody complex (Litt, 1964). In present study the increase eosinophils could be due to local immune response in the gut which
induced circulating and tissue hyper-eosinophilia as reported by Dawkins et al., (1989).
**Basophil count (%)**

The mean ± SE value of basophils of apparently healthy horses and gastrointestinal parasites infested horses were 0.6±0.26 and 0.7±0.18 per cent, respectively.

The mean value of basophils of gastrointestinal parasites infested horses were did not show any significant difference when compared to mean value of apparently healthy horses.

The finding of present study is in similar with the findings of Smith (1976) and Sipra et al., (1999). They found no appreciable changes in basophils in gastrointestinal parasites infested horses.

**4.4.6 Total eosinophil count (/µl)**

The mean ± SE value and range of Total eosinophil count of apparently healthy and gastrointestinal parasites infested horses have been presented in Table 7, Appendix V and IX.

**Table 7: Mean ± SE value of total Total eosinophil count of apparently healthy and gastrointestinal parasites infested horses.**

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently healthy</td>
<td>271 ± 13.46a</td>
<td>178-333</td>
</tr>
<tr>
<td>Infested Horses</td>
<td>514.4 ± 43.23b</td>
<td>355-977</td>
</tr>
</tbody>
</table>

Different superscripts differ significantly (P< 0.01)

The mean ± SE value of total eosinophil count of apparently healthy horses and gastrointestinal parasites infested horses were 271 ± 13.46 and 514.4 ± 43.23 per µl respectively.

The mean values of Total eosinophil count of gastrointestinal parasites infested horses were found significantly increase (P< 0.01) when compared to mean value of apparently healthy horse.
The finding of present study is in conformity with the finding of Sipra et al., (1999) and Smith (1976). They found significantly changes in eosinophil counts in gastrointestinal parasites infested horses. The findings of present study are also similar to that of McCraw and Slocombe (1985); Chaudhary et al., (1991); Mahboob et al., (2008).

The increase in eosinophil count was due to the extremely elevated levels of IgE in parasitized individuals which mediate mast cell degranulation thereby stimulate release of eosinophil chemotactic factor of anaphylaxis. This material, in turn mobilizes the body's eosinophil pool resulting in the release of large number of eosinophil into the circulation (Tizzard, 1982).

4.5 Biochemical parameters

4.5.1 Total serum protein (g/dl)

The mean ± SE value and range of serum total protein of apparently healthy and gastrointestinal parasites infested horses have been presented in Table 8, Appendix V, IX, and depicted in Figure 5.

Table 8: Mean ± SE value of total serum protein of apparently healthy and gastrointestinal parasites infested horses.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently healthy</td>
<td>6.46 ± 0.12\textsuperscript{a}</td>
<td>6-7.4</td>
</tr>
<tr>
<td>Infested Horses</td>
<td>7.04 ± 0.10\textsuperscript{b}</td>
<td>6.4-8</td>
</tr>
</tbody>
</table>

Different superscripts differ significantly (P< 0.01)

The mean ± SE value of serum total protein of apparently healthy horses and gastrointestinal parasites infested horses were 6.46 ± 0.12 and 7.04 ± 0.10 g/dl, respectively.

The mean values of total serum protein of gastrointestinal parasites infested horses were found significantly increase (P< 0.01) when compared to mean value of apparently healthy horse.
The finding of present study is in conformity with the finding of Duncan and Dargie (1975) Hubert et al., (2004). They found significantly increase in total serum protein in gastrointestinal parasites infested horses. The findings of present study are also similar to that of McCraw and slocombe (1976); Dennis et al., (1992); Steinbach et al., (2006). However, the present finding is contrary to the finding of Smets et al., (1999) and Bodecek et al., (2010). They found decrease total serum protein level in gastrointestinal parasites infested horses.

A significant increase in total serum protein was noted in gastrointestinal parasites infested horses in comparison to the apparently healthy horses. The increase in total serum protein was possibly due to increases in antigenically immunoglobulins. One of immunoglobulin T, with $\beta_2$ electrophoretic mobility is attributed to increase in of $\beta$ globulin in helminthic infections (Patton et al., 1978).

4.5.2 Albumin (g/dl)

The mean ± SE value and range of serum albumin of apparently healthy and gastrointestinal parasites infested horses have been presented in Table 9, Appendix V, IX, and depicted in Figure 5.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently healthy</td>
<td>3.7 ± 0.08$^b$</td>
<td>3.2-4</td>
</tr>
<tr>
<td>Infested Horses</td>
<td>2.79 ±0.10$^a$</td>
<td>2.2-3.4</td>
</tr>
</tbody>
</table>

Different superscripts differ significantly (P< 0.01)

The mean ± Se values of serum albumin of apparently healthy horses and gastrointestinal parasites infested horses were 3.7 ± 0.08 and 2.79 ±0.10 g/dl, respectively.

The mean values of serum albumin of gastrointestinal parasites infested horses were found significantly low (P< 0.01) when compared to mean value of apparently healthy horse.
The finding of present study is in conformity with the findings of Murphy et al., (1997). They found significantly decrease in serum albumin in Cyathostome infested horses. The findings of present study are also similar to that of Jasko and Rath (1984); Giles et al., (1985); Loon et al., (1995); Smets et al., (1999); Thamsborg (1998); Lyon et al., (2000); Corning (2009); Bodecek et al., (2010). They found hypoalbuminemia in gastrointestinal parasites infested horses.

The hypoalbuminemia was consistent with an inflammatory process involving external blood loss, such as widespread intestinal mucosal damage. Severe hypoalbuminemia in horses most commonly results from excessive intestinal or renal protein loss. Significant proteinuria in horses is rare. Intestinal protein loss may be due to bleeding from mucosal ulceration associated with neoplastic infiltrates, or protein exudation associated with intestinal inflammation, most commonly due to intestinal parasitism (Peregine et al., 2006). The decrease in albumin is a common form of hypoproteinaemia. Due to its small size and osmotic sensitivity of fluid movements, albumin is selectively lost in intestinal parasitism (Dobson, 1965).

4.5.3 Globulin (g/dl)

The mean ± SE value and range of serum globulin of apparently healthy and gastrointestinal parasites infested horses have been presented in Table 10, Appendix V, IX, and depicted in Figure 5.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently healthy</td>
<td>2.79 ± 0.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.4-4</td>
</tr>
<tr>
<td>Infested Horses</td>
<td>4.25 ± 0.09&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.2-5</td>
</tr>
</tbody>
</table>

Different superscripts differ significantly (P< 0.01)

The mean ± SE value of serum globulin of apparently healthy horses and gastrointestinal parasites infested horses were 2.79 ± 0.13 and 4.25 ± 0.09 g/dl, respectively.
The mean value of serum globulin of gastrointestinal parasites infested horses was found significantly increase (P< 0.01) when compared to mean value of apparently healthy horse.

The finding of present study is in conformity with the findings of McCraw and Slocombe (1985) and Duncan and Piric (1975). They found significantly increase serum globulin in *Strongylus equinus* and *Strongylus vulgaris* infested pony foals, respectively. The findings of present study are also similar to that of McCraw and slocobbe (1976); Jasko and Rath (1984); Giles *et al.*, (1985); Dennis *et al.*, (1992); Smets *et al.*, (1999); Thamsborg *et al.*, (1998); Lyon *et al.*, (2000); Corning (2009).

In the present study the globulin value of gastrointestinal parasites infested horses was significantly higher which might be attributed to the direct loss of albumin into the gut through the lesion produced by the gastrointestinal helminthes particularly blood sucking parasites (Soulsby, 1982).

### 4.5.4 A: G ratio

The mean ± SE value and range of albumin and globulin ratio of apparently healthy and gastrointestinal parasites infested horses have been presented in Table 11, Appendix V, IX, and depicted in Figure 5.

**Table 11: Mean ± SE value of serum albumin and globulin ratio of apparently healthy and gastrointestinal parasites infested horses.**

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SE</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently healthy</td>
<td>1.37 ± 0.08 b</td>
<td>1-1.81</td>
</tr>
<tr>
<td>Infested Horses</td>
<td>0.66 ± 0.03 a</td>
<td>0.43-1.06</td>
</tr>
</tbody>
</table>

Different superscripts differ significantly (P< 0.01)

The mean ± SE value of albumin and globulin ratio of apparently healthy horses and gastrointestinal parasites infested horses were 1.37 ± 0.08 and 0.66 ± 0.03, respectively.
The mean value of albumin and globulin ratio of gastrointestinal parasites infested horses was found significantly lower (P< 0.01) when compared to mean value of apparently healthy horse.

The finding of present study is similar with the findings of Thamborg (1998) and Loon et al., (1995). They found albumin/globulin ratio low.

The albumin/globulin ratios (comprising both lower shifted albumin and higher shifted globulin), are potential indicators of poor immune function (Pritchard et al., 2009). The lower albumin and globulin ratio recorded in present study might be due to non stimulation of globulin formation by adult parasites and significant decrease in albumin and significant increase in globulin values in the present study.
4.6 Therapeutic efficacy of ivermectin

Therapeutic efficacy of ivermectin against gastrointestinal helminthes of horses presented in Table 12.

**Table 12: Therapeutic efficacy of Ivermectin against gastrointestinal parasites infested horses on 15th day.**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose and route of administration</th>
<th>Egg per gram (MEAN±SE) On 0 day</th>
<th>Egg per gram (MEAN±SE) On 15 day</th>
<th>Per cent efficacy on 15th day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ivermectin</td>
<td>0.20 mg/kg body weight, orally</td>
<td>825± 58.77a</td>
<td>20 ± 9.17b</td>
<td>97.57</td>
</tr>
</tbody>
</table>

Different superscripts differ significantly (P< 0.01)

Ivermectin tablet given orally as a single dose at the rate of 0.20 mg/kg body weight reduced the mean egg per gram of gastrointestinal helminthes from average counts of 825 ± 58.77 to 20 ± 9.17 with the average reduction of 97.57 percent on 15th day.

The efficacy of ivermectin in present study was 97.57 per cent analyzed by comparing reduction of mean epg counts between 0 day as pre treatment and on 15th day as post treatment. A significant (P< 0.01) decrease in the mean epg counts was recorded in gastrointestinal parasite infested horses.

The efficacy of ivermectin against gastrointestinal parasites in horses has been recorded earlier by many workers. It has been reported that 97% (Klei and Torbert 1980); 98% (Torbert et al., 1982); 98% (Barragry 1987); 96.9 to 100% (Larsen et al., 2011).

Ivermectin is highly effectively for the treatment and control of a broad range of small and large *Strongyle* species as well as other species of gastrointestinal
parasites (Hassan et al., 2005). In present study the prevalence of nematode was high in comparison to other gastrointestinal parasites.

Gamma-amino-butyric acid (GABA) is the neurotransmitter substance mediating transmission of inhibitory signals from the inter neurons to the motor neurons in the ventral nerve cord of nematode parasites. The overall GABA-mediated chloride ion conductance effect may be due to (a) ivermectin acting as a GABA agonist either at the GABA binding site or elsewhere on the protein, (b) stimulation of presynaptic GABA release, or (c) potentiation of GABA binding to its receptors. The paralysis is the most evident effect of ivermetin in parasites (Barragry 1987).

**Conclusion**

One hundred horses irrespective of sex, age and breed were screened for gastrointestinal parasitism in and around Bikaner.

The findings of present investigation concluded that overall prevalence of gastrointestinal parasites was 39 per cent, including *Strongyle* spp. (71.79 %), *Parascaris equorum* (20.51%), *Oxyuris equi* (12.82%), *Anoplocephala* spp. (7.69%), *Triodontophrous* (7.69%), *Strongyloides westeri* (5.12%), *Habronema* (5.12%) and protozoa *Eimeria leuckarti* 2.56 per cent, respectively.

Common clinical signs recorded in horses infested with gastrointestinal parasites included weakness, dullness, anorexia, diarrhoea, rough hair coat, loss of body weight, anaemia, poor body condition, eating of inanimate objects, loss of vigour and reduced in work performance. It was also noticed that few moderately infested horses suffered from poor appetite and general weakness. In heavy infestation horses suffered from pyrexia, colic and lameness.

The overall mean values of eggs per gram of faeces in 20 horses affected with gastrointestinal parasites in the present study were 825±58.77 with a range of 500-1600 E.P.G.

Haemato-biochemical studies in gastrointestinal parasites infested horses revealed significant decrease in haemoglobin, packed cell volume, total erythrocyte counts, lymphocytes, serum albumin, albumin globulin ratio and significant increase
in eosinophil, total eosinophil counts, total serum protein, serum globulin when compared with apparently healthy horses.

The therapeutic efficacy of ivermectin against gastrointestinal parasites in horses was 97.57 per cent recorded on 15\textsuperscript{th} day post treatment.
5. SUMMARY

The contribution of horse population of our country is well accepted in the field of transportation, sports, stamina in battle field, recreation, and ceremonial purpose in addition to livelihood of many families. Gastrointestinal parasites are considered as major hurdles against horse management.

Keeping the above facts in mind, the present study was carried out to determine the prevalence of gastrointestinal parasites in horses of Bikaner city. In present study hematological and biochemical parameter as well as efficacy of ivermectin was also assessed.

One hundred horses irrespective of sex, age and breed were screened for gastrointestinal parasites. These animals were included from the horses brought to the Veterinary Medicine Clinic of College of Veterinary and Animal Sciences, Bikaner, nearby villages like Udasar, Nokha, poonrasar, Shri Kolayat, Ganashahar, Khara Village, as well as horses belonging to individual holdings in and around Bikaner. On the basis of history, clinical manifestation and faecal examination, a total of 20 positive cases of gastrointestinal parasitism were selected irrespective of age, sex and breed for therapeutic efficacy of ivermetin.

Overall prevalence of gastrointestinal parasites was 39 per cent, including Strongyle spp. (71.79 %), Parascaris equorum (20.51%), Oxyuris equi (12.82%), Anoplocephala spp. (7.69%), Triodontophrous (7.69%), Strongyloides westeri (5.12%), Habronema (5.12%) and protozoa Eimeria leuckarti 2.56 per cent respectively.

Common clinical signs recorded in horses infested with gastrointestinal parasites included weakness, dullness, anorexia, diarrhoea, rough hair coat, loss of body weight, anaemia, poor body condition, eating of inanimate objects, loss of vigour and reduced in work performance. It was also noticed that few moderately infested horses suffered from poor appetite and general weakness. In heavy infestation horses suffered from pyrexia, colic and lameness.
The overall mean values of eggs per gram of faeces in 20 horses affected with gastrointestinal parasites in the present study were 825±58.77 with a range of 500-1600 egg per gram.

The haemato-biochemical values showed significant decrease in haemoglobin, packed cell volume, total erythrocyte counts, lymphocytes, serum albumin, albumin globulin ratio and significant increase in eosinophil, total eosinophil counts, total serum protein, serum globulin in gastrointestinal parasites infested horses. Total erythrocytes count, neutrophils, monocytes and basophils showed no significant changes as compared to apparently healthy horses.

In the present study the therapeutic efficacy of ivermectin against gastrointestinal parasites in horses was 97.57 per cent recorded on 15th day post treatment.
6. LITERATURE CITED


Gundach, J.L., Sadzikowski, A.B., Tomczuk, K. and Studzinska M.B. (2004). Parasites of the alimentary tract of horses from the Lublin district in the


Haemato-biochemical and Therapeutic studies on gastrointestinal parasitism in horses

M.V.Sc. Thesis
Department of Epidemiology and Preventive Veterinary Medicine
College of Veterinary and Animal Science
Rajasthan University of Veterinary and Animal Sciences,
Bikaner-334001

Submitted by: Shadab Ahmed Khan
Major Advisor: Dr. R.K. Tanwar

ABSTRACT

The present investigation was carried out in one hundred horses in and around Bikaner. The faecal samples were examined by direct smear, flotation and sedimentation methods for detection of any parasitic infection based on the presence of parasitic egg/oocyst by any or all of these methods. On the basis of faecal examination, an overall prevalence of gastrointestinal parasites was 39 per cent. Out of 39 horses, prevalence of *Strongyle* spp. was highest 28 (71.79 %) followed by 8 (20.51%) *Parascaris equorum*, 5 (12.82%) *Oxyuris equi*, 3 (7.69%) *Anoplocephala spp.*, 3 (7.69%) *Triodontophrous*, 2 (5.12%) *Strongyloides westeri*, 2 (5.12%) *Habronema* and protozoa 1 (2.56%) *Eimeria leuckarti*.

The clinical signs in gastrointestinal parasites infested horses included weakness, dullness, anorexia, diarrhoea, rough hair coat, loss of body weight, anaemia, poor body condition, eating of inanimate objects, loss of vigour and reduced in work performance. It was also noticed that few moderately infested horses suffered from poor appetite and general weakness. In heavy infestation horses suffered from pyrexia, colic and lameness.

The overall mean ± SE values of eggs per gram of faeces in 20 horses affected with gastrointestinal parasites in the present study were 825 ± 58.77 with a range of 500-1600 egg per gram.
Haemato-biochemical studies in (20) gastrointestinal parasites infested horses revealed significant decrease in haemoglobin, packed cell volume, total erythrocyte counts, lymphocytes, serum albumin, albumin globulin ratio and significant increase in eosinophil, total eosinophil counts, total serum protein, serum globulin when compared with apparently healthy horses.

The therapeutic efficacy of ivermectin against gastrointestinal parasites in horses was 97 per cent recorded on 15th day post treatment.
LukrdksÙkj 'kks/k xzUFk
tuokndh; jksx foKku ,oa fuokjd i'kq vkS"k/k foKku foHkkx
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jktLFkku i'kq fpfdRlk ,oa i'kq foKku fo'ofo|ky;]
chdkusj 334001

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eq[; mins"Vk%      MkW-       vkj-ds-
                    rjoj

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orZeku vUos{k.k chdkusj ,oa bldh ifjf/k esa fLFkr ,d lkS
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69 izfr'kr½ VªkbZvksMksUVksQksjl 3¼7-69 izfr'kr½]
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tBjkU=h; ijthoksa ls xzfLr v'oksa ds }jk iznf'kZr y{k.kksa esa detksjh] fujk'kk] Hkkstu ds izfr vfuPNk] vfrkj] dBksj cky vkoj.k] 'kkjhfjd otu esa deh] jäkYirk ¼jDr vYork½ nqcZy vLoFkk] v[kk] inkFkksZ dks [kkuk] tks'k esa deh] rFkk dk;Z {kerk esa deh ns[kh x;h FkhA ;g Hkh ns[kk x;k dh dqN e/;e ihfM+r v'o Hkq[k esa deh rFkk lEiw.kZ detksjh ls xzfLr FksA vf/kd ihfM+r v'o cq[kkj] isV nnZ rFkk yxM+siu ls xzfLrA FksA

v/;;u gsrq pqus gq, 20 v'o tks tBjkU=h; ijthoks ls xzfLr Fks mu esa lEiw.kZ vkSlr ± ekud =qfV ey ds izfr xzke v.Mksa esa 825±58-77 ik;k x;k tks 500&1600 ds e/; foLrkfjr FksA
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v'oksa esa tBjkU=h; ijthoksa ds f[kykQ vkbojesfDVu dh fpfdRIh; izHkkodkfjrk 15 fnu ds bykt ds ckn 97-57 izfr'kr ntZ dh xbZ FkhA
LIST OF ABBREVIATIONS

% Per cent
gm Gram
Hb Haemoglobin
EPG Eggs Per Gram
PCV Packed cell volume
TLC Total leucocyte count
TEC Total erythrocyte count
DLC Differential leucocyte count
n Number
i/m Intramuscular
Kg Kilogram
mg Milligram
ml Milliliter
dl Deciliter
b.wt. Body weight
i.e. That is
Spp. Species
Viz. Namely
µg Microgram
O.D Optical density
S.No. Serial number
et al. et alii (and others)
g/dl Gram per deci-liter
cu.mm Cubic millimeter
N Neutrophil
L Lymphocyte
B Basophil
M Monocyte
E Eosinophil
G. I. Gastrointestinal
A : G Ratio Albumin : Globulin ratio
Appendix II: Value of Haemoglobin (gm %), Packed cell volume (%), Total Erythocyte count (million/cumm) and Total leucocyte count (thousand/cumm) of apparently healthy horses.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Hb</th>
<th>PCV</th>
<th>TEC</th>
<th>TLC</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>14</td>
<td>30</td>
<td>7.89</td>
<td>8.70</td>
</tr>
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</tr>
<tr>
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<td>7.00</td>
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<td>10.5</td>
<td>30</td>
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<tr>
<td>7</td>
<td>15</td>
<td>42</td>
<td>9.50</td>
<td>8.55</td>
</tr>
<tr>
<td>8</td>
<td>12.2</td>
<td>32</td>
<td>6.90</td>
<td>7.80</td>
</tr>
<tr>
<td>9</td>
<td>11.2</td>
<td>34</td>
<td>8.30</td>
<td>9.20</td>
</tr>
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<td>10</td>
<td>11.6</td>
<td>30</td>
<td>7.20</td>
<td>9.90</td>
</tr>
<tr>
<td>Mean ± SE</td>
<td>12.2±0.49</td>
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<td>7.88±0.24</td>
<td>8.94±0.33</td>
</tr>
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<td>Range</td>
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<td>6.90-9.50</td>
<td>7.50-11</td>
</tr>
</tbody>
</table>

Appendix III: Differential leucocyte count of apparently healthy horses

<table>
<thead>
<tr>
<th>S.No.</th>
<th>N%</th>
<th>L%</th>
<th>M%</th>
<th>E%</th>
<th>B%</th>
</tr>
</thead>
<tbody>
<tr>
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<td>52</td>
<td>43</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
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<td>3</td>
<td>50</td>
<td>46</td>
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</tr>
<tr>
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<td>47</td>
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<tr>
<td>5</td>
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<tr>
<td>6</td>
<td>54</td>
<td>42</td>
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<td>2</td>
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</tr>
<tr>
<td>7</td>
<td>50</td>
<td>45</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
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</tr>
<tr>
<td>9</td>
<td>51</td>
<td>43</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>45</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Mean ± SE</td>
<td>49.8±0.69</td>
<td>44.7±0.49</td>
<td>2.6±0.21</td>
<td>2.3±0.21</td>
<td>0.6±0.26</td>
</tr>
<tr>
<td>Range</td>
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<td>42-47</td>
<td>2-5</td>
<td>1-3</td>
<td>0-2</td>
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</tbody>
</table>
Appendix IV: Total serum protein, albumin, globulin and A:G ratio of apparently healthy horses.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Total serum protein (g/dl)</th>
<th>Albumin (g/dl)</th>
<th>Globulin (g/dl)</th>
<th>A:G ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.2</td>
<td>3.4</td>
<td>2.8</td>
<td>1.21</td>
</tr>
<tr>
<td>2</td>
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<td>6.2</td>
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<td>4</td>
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<td>5</td>
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<td>4.0</td>
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<td>4.0</td>
<td>2.4</td>
<td>1.66</td>
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<tr>
<td>Mean ± SE</td>
<td>6.46±0.12</td>
<td>3.7±0.08</td>
<td>2.76±0.13</td>
<td>1.37±0.08</td>
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<td>Range</td>
<td>6.0-7.4</td>
<td>3.2-4</td>
<td>2.4-4</td>
<td>1-1.81</td>
</tr>
</tbody>
</table>

Appendix V: Total Eosinophil count of apparently healthy horses.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Total eosinophil count</th>
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<tbody>
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<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>9</td>
<td>266</td>
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<td>10</td>
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</tr>
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<td>Mean ± SE</td>
<td>271±13.46</td>
</tr>
<tr>
<td>Range</td>
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</table>
Appendix VI: Value of Haemoglobin (gm%), Packed cell volume (%), Total Erythocyte count (million/cumm) and Total leucocyte count (thousand/cumm) of gastrointestinal parasites infested horses.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Hb</th>
<th>PCV</th>
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<th>TLC</th>
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Appendix VII: Differential leucocyte count of gastrointestinal parasites infested horses.

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Appendix VIII: Total serum protein, albumin, globulin and A:G ratio of gastrointestinal parasites infested horses.

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Appendix IX: Total Eosinophil count of gastrointestinal parasites infested horses.

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Mean ± SE 514.4±43.23

Range 355-977
Appendix X: Egg per gram (EPG) of gastrointestinal parasites infested horses at 0\textsuperscript{th} and 15\textsuperscript{th} day post administration of tablet Ivermectin.

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Appendix I: Prevalence of gastrointestinal parasites in horses in and around Bikaner.

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<td>+</td>
<td>+</td>
</tr>
<tr>
<td>97</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>98</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>99</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>100</td>
<td>-</td>
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</tr>
<tr>
<td>Overall</td>
<td>39%</td>
<td>28 (71.79%)</td>
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Fig. 3 - Mean values of blood Hb, PCV, TEC and TLC

<table>
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<th>Parameter</th>
<th>Apparently healthy horses</th>
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<tr>
<td>Hb (gm%)</td>
<td>12.2</td>
<td>8.97</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>34.6</td>
<td>28.3</td>
</tr>
<tr>
<td>TEC (mill./cumm)</td>
<td>6.08</td>
<td>7.88</td>
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<tr>
<td>TLC (th./cumm)</td>
<td>8.94</td>
<td>8.94</td>
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Fig. 4 - Mean values of Differential leucocyte count

<table>
<thead>
<tr>
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<tr>
<td>Neutrophil (%)</td>
<td>49.8</td>
<td>51.15</td>
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<tr>
<td>Lymphocyte (%)</td>
<td>44.7</td>
<td>41.6</td>
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<tr>
<td>Monocyte (%)</td>
<td>2.6</td>
<td>3</td>
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<tr>
<td>Eosinophil (%)</td>
<td>3</td>
<td>2</td>
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</table>
Fig. 5 - Mean values of total serum protein, albumin globullin and A:G Ratio

<table>
<thead>
<tr>
<th></th>
<th>Apparently healthy horses</th>
<th>Infested horses</th>
</tr>
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<tbody>
<tr>
<td>Total serum protein</td>
<td>6.46</td>
<td>7.04</td>
</tr>
<tr>
<td>Albumin</td>
<td>3.7</td>
<td>2.79</td>
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<tr>
<td>Globulin</td>
<td>2.76</td>
<td>4.25</td>
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</table>
Haemato-biochemical and Therapeutic studies on gastrointestinal parasitism in horses

अश्वों में जटरांग्रीय परजीविता पर रक्त जैव रासायनिक एवं चिकित्सीय अध्ययन

SHADAB AHMED KHAN
B.V.Sc. & A.H.

THESIS
Master of Veterinary Science
(Epidemiology and Preventive Veterinary Medicine)

2012

Department of Epidemiology and Preventive Veterinary Medicine
College of Veterinary and Animal Science, Bikaner
Rajasthan University of Veterinary and Animal Sciences,
Bikaner 334001 (Rajasthan)
Haemato-biochemical and Therapeutic studies on gastrointestinal parasitism in horses.

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THESIS

Submitted to the
Rajasthan University of Veterinary and Animal Sciences,
Bikaner
In partial fulfilment of the requirements for
the degree of

Master of Veterinary Science
(Epidemiology and Preventive Veterinary Medicine)
FACULTY OF VETERINARY & ANIMAL SCIENCE

By
SHADAB AHMED KHAN
B.V.Sc. & A.H.

2012
This is to certify that Mr. SHADAB AHMED KHAN had successfully completed the comprehensive examination held on ............... as required under the regulation for the degree of Master of Veterinary Science.

(R.K. Tanwar)
Head
Department of Epidemiology and Preventive Veterinary medicine
College of Veterinary and Animal Science
Bikaner
CERTIFICATE – II

Date................

This is to certify that this thesis entitled “Haemato-biochemical and Therapeutic studies on gastrointestinal parasitism in horses” submitted for the degree of Master of Veterinary Science in the subject of Epidemiology And Preventive Veterinary Medicine embodies bonafide research work carried out by Mr. SHADAB AHMED KHAN under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation has been fully acknowledged. The draft of the thesis was also approved by the Advisory Committee on .................

(R.K Tanwar) (R.K. Tanwar)
Head Major advisor
Department of Epidemiology and Preventive Veterinary Medicine

DEAN
College of Veterinary and Animal Science, Bikaner
This is to certify that the thesis entitled “Haemato-biochemical and Therapeutic studies on gastrointestinal parasitism in horses” submitted by Mr. SHADAB AHMED KHAN to Rajasthan University of Veterinary and Animal Sciences, Bikaner, in partial fulfillment of the requirement for the degree of Master of Veterinary Science in the subject of Epidemiology and Preventive Veterinary Medicine after recommendation by the external examiner was defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination on his thesis has been found satisfactory. We therefore recommend that the thesis be approved.

(R.K. Tanwar) (Fakhruddin)  
Major advisor Advisor

(A.K. Kataria) (Anil Ahuja)  
Advisor Dean P.G.S Nominee

(R.K. Tanwar)  
Head  
Department of Epidemiology and Preventive Veterinary Medicine,  
College of Veterinary and Animal Science,  
Bikaner.

Approved

Dean  
Post Graduate Studies  
Rajasthan University of Veterinary and Animal science, Bikaner
CERTIFICATE – IV

Date.............

This is to certify that Mr. SHADAB AHMED KHAN of the Department of Epidemiology and Preventive Veterinary Medicine, College of Veterinary and Animal science, Bikaner has made all corrections/modifications in the thesis entitled “Haemato-biochemical and Therapeutic studies on gastrointestinal parasitism in horses” which were suggested by the external examiner and the advisory committee in the oral examination held on................. .The final copies of the thesis duly bound and corrected were submitted on ............., are enclosed herewith for approval.

(R.K Tanwar) (R.K. Tanwar)
Head Major Advisor
Department of Epidemiology and Preventive Veterinary Medicine

Dean
College of Veterinary and Animal science, Bikaner.

Approved

Dean
Post Graduate Studies
Rajasthan University of Veterinary and Animal science, Bikaner
Acknowledgement

The almighty is the first, before whom I bow my head with great reverence because without his endless blessings no task can be accomplished.

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Place: SHADAB AHMED KHAN

Date
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INTRODUCTION
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RESULTS & DISCUSSION
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(English and Hindi)
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